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# PHARYNGO-ESOPHAGEAL DIVERTICULUM

E. STARR JUDD AND HERMAN J. MOERSCH

THE diagnosis of the presence of pharyngo-esophageal diverticulum is made erroneously probably more frequently than that of any other disease of the esophagus. Correctly, such diverticula should be called pharyngeal diverticula, as they always arise from the lower posterior wall of the pharynx through a weakened area in the lower portion of the inferior constrictor muscles where they join the esophagus. This point is situated directly opposite the cricoid cartilage, and the name "pharyngeal dimple" is frequently applied to it. The diverticulum is of the pulsion type and consists of herniation of the mucosa and submucosa through the weakened area, and is characterized by lack of a muscular coat as compared to traction diverticula which possess such a cover. The exact cause is uncertain, but probably the condition is due to incoördination in the process of deglutition, trauma, and a decrease in elasticity of the tissues.

The condition is predominantly one of old age. It seldom occurs before the age of forty-five years and is most frequently found in the fifth and sixth decades. It is far more common in men. When present in women, it usually does not attain the large size seen in men. The onset is insidious and five years may elapse before surgical procedures are carried out. The first symptom is usually a sense of irritation of the throat with an accumulation of mucus. Solid particles of food lodge in the

throat and produce a sensation of choking. The degree of dysphagia usually becomes progressively more marked and is dependent largely on the size of the sac, being more severe if the pouches are large.

Regurgitation of particles of food and mucus is a very annoying symptom, and the patient frequently complains of it at night, on lying down, or when stooping over. Many patients must regurgitate immediately after eating, and find it, therefore, very embarrassing to partake of a meal away from home, as they must excuse themselves and retire to empty the sac. They often acquire the habit of emptying the sac at night before retiring. Frequently a small stomach-tube is used for this purpose.

A gurgling noise on swallowing is commonly present, especially if the sac is large. There is often a distinct change in speech as if the patients were trying to talk with something in the mouth. Many patients are troubled with an irritating cough, especially on lying down at night, which usually persists until the sac is empty. The diverticulum tends to present on the left side due to the normal inclination of the esophagus to this side in the cervical region. A diagnostic sign of diverticulum is elicited in the following manner:

The patient is requested to swallow a small amount of water or even air and then instructed to hold the mouth open. Sharp pressure is made on the left side of the neck, and if a gurgling sound is produced the diagnosis of a pharyngo-esophageal diverticulum can be made with great accuracy.

Loss of weight is usually present and is dependent on the degree of obstruction, being very marked in those with marked obstruction. The diagnosis can usually be made from the history and the diagnostic sign elicited by pressure on the neck. Roentgenologic examination, passage of a sound over a previously swallowed silk thread, and esophagoscopy give added and valuable information. The roentgenologic data are of the greatest value and present a typical picture. Practically the only condition that it may be confused with is carcinoma situated high in the esophagus, and this may be easily ruled out by a

fluoroscopic examination which shows the sac filling and emptying from above in diverticulum, and emptying from below in carcinoma.

The passage of sounds over a previously swallowed silk thread gives considerable valuable information. The thread proves of inestimable value in the preoperative care, and in the care of the patient during and after operation.

The passage of a blunt olive over this thread, as described by Plummer in 1909, and later by Vinson, gives absolutely confirmatory evidence. The greatest value in the passage of the sound is to determine any possible stricture or growth below the sac or, what is very rarely seen, a secondary malignant change in the diverticulum. When any evidence is obtained of such a change, esophagoscopy is performed which may enable one to confirm or deny the presence of a diverticulum and examine and remove a specimen for diagnosis.

The reason we do not recommend esophagoscopy as a routine measure is because of the difficulty and associated danger and at times the sparsity of information obtained, even by experienced observers.

In cases in which the patient is markedly dehydrated and undernourished, due to dysphagia, and in which operative risk is grave unless fluids can be forced and nutrition increased, the thread is of incalculable value. Through the use of a whale-bone staff and an ordinary Plummer spiral, a Sawyer type of stomach-tube can be quickly and easily passed into the stomach; ordinarily in such cases it is almost impossible to pass a stomach-tube without a guide. In this way food and fluids can be furnished easily and, what is of greater importance, it is not necessary to have the tube in place, as it can be removed after each feeding if so desired, thereby affording the patient greater comfort.

The thread is left in place in all cases in which surgical procedures are to be carried out. Although the surgeon can usually quickly and easily isolate the sac, if any difficulty should be encountered in outlining the sac or the esophagus, it requires only a moment and very little confusion to slip a sound over

the thread into the sac or into the esophagus and furnish such information to the surgeon with the least amount of discomfort to the patient.

The conditions with which pharyngo-esophageal diverticulum may be confused are: Cardiospasm, bulbar palsy, carcinoma, cicatricial stricture of the esophagus, globus hystericus, and functional and hysterical dysphagia. If the examinations already mentioned are done there is very little chance of error.

## REPORT OF CASE

A woman aged sixty-seven years had had symptoms referable to the esophagus for five years. The first symptom was dysphagia, noticed on swallowing solid particles of food. This was practically her only symptom until a year previous to examination, when she began to regurgitate small quantities of food; this occurred only when she stooped over. The condition had become progressively worse and during the last six months she had regurgitated small amounts about every hour until about midnight, and it was only after the sac was well emptied that she was able to go to sleep. She had likewise been conscious of a peculiar gurgling noise on swallowing and of some change in her voice. She had lost about 20 pounds during the last two years.

On examination the first thing that impressed one was the type of speech, which was very much as if the patient had some mush in her mouth, and it was associated with a peculiar noise on swallowing. When she was requested to swallow and open her mouth and then sudden pressure made on the left side of the neck, there was a peculiar gurgling sound. Roentgen-ray examination revealed a typical pharyngo-esophageal diverticulum. On passage of a sound over a previously swallowed silk thread the characteristics of pharyngo-esophageal diverticulum were revealed without evidence of obstruction in the esophagus. A thread was left in place and the patient was referred for operation.

In operations on pharyngo-esophageal diverticula it has always seemed best to make the incision on the left side of the neck even though the sac may be on the right side. A local anesthetic in the form of a cervical block is the ideal one. Usually the operation can be performed without discomfort to the patient, even when rather tedious dissection into the mediastinum is required in order to free the lower end of the sac from the surrounding tissues. The incision is made along the anterior border of the sternocleidomastoid muscle. It should be long enough to allow ample exposure, as practically no scar follows,

and working in a crowded field may make the operation difficult. The incision extends down to the sternocleidomastoid muscle, then continues in front of it, and the muscle is retracted outward. The spinal accessory nerve must be avoided. After the dissection has been carried to the carotid sheath its direction should be to the inner side of the sheath so that the carotid artery, the vagus, and the jugular vein are reflected outward. Continuing in this way, the anterior surface of the vertebra and the posterior wall of the esophagus are soon reached. The neck of the sac will be found directly behind the cricoid cartilage, but the sac itself will lie below in the anterior mediastinum. After the sac has been dissected free from the surrounding tissues there are three different types of operation that may be employed. It must be kept in mind that the sac is a portion of the mucosa and submucosa which has bulged out between the muscular fibers of the esophagus. On this account it is necessary to continue the dissection down to the muscular coats of the esophagus. If the sac is not completely freed there will later be a tendency for it to recur, or should the dissection be carried too far into the wall of the esophagus, narrowing of the lumen may result.

One of the three types of operation is that described by Gerard and Bevan. After the neck of the sac has been completely freed from the surrounding tissues, purse-string sutures and plicating stitches are so placed that when the sac is tucked into the esophagus and these stitches are tightened, the sac will be permanently held in the lumen of the esophagus, where it will atrophy or slough off. Although this method may be applicable in some cases in which the sac is small, it seems to us that the better plan is eventually to remove the sac.

A second type of operation is one that was formerly used a great deal and one which is still advocated by many. It consists in the complete excision of the sac and suture of the wall of the esophagus in one stage. This would be the ideal operation were it not for the danger of leakage at the suture line due to the fact that there is considerable traction on it every time the patient swallows. Infection may result from the leakage

and its tendency is always downward into the mediastinum. Of course this is a serious complication.

The third method of operating is that suggested by J. B. Murphy and C. H. Mayo. It is a two-stage procedure in which the chances of mediastinal infection are avoided. This type of operation was performed in the case reported here. The first stage consists in freeing the sac in the usual manner and dissecting the mucous membrane away from the musculature of the esophagus. Then the neck of the sac is caught to the sternocleidomastoid muscle or even to the platysma muscle with a few interrupted catgut sutures, and the wound in the neck is closed around the neck of the diverticulum, allowing the entire sac to prolapse from the wound. In the event that the sac is small and not long enough to come outside of the wound, a suture of silk may be attached to the sac so that it can be readily identified at the time of the second operation. During the first stage neither the esophagus nor the sac is opened, so there is no danger of infection. It is not advisable to twist the neck of the sac at this stage. It is allowed to remain prolapsed through the wound for about eight days. During this time the patient is permitted to be up out of bed. The patient is usually able to swallow without any difficulty, for the lumen of the esophagus was reëstablished when the sac was elevated and placed in this position in the neck. At the end of about a week a complete barrier of granulation tissue will have formed, so that the neck of the diverticulum is separated from the mediastinum and it is perfectly safe to open the wound again, grasp the fundus of the sac, bring it up, ligate its neck, and remove the diverticulum. After ligation of the neck of the sac with chromic catgut it is usually not best to attempt to suture over the wall of the esophagus. A small drain is placed down into the bottom of the field and the wound is closed. Dry heat in the form of an electric light bulb placed over the wound for an hour or two each day helps to encourage primary healing. The drain is removed on the fourth or fifth postoperative day. The patient is allowed to begin taking nourishment two days after the second stage of the operation has been completed (Figs. 295, 296).

Since we have been using this two-stage procedure in operating for esophageal diverticula practically no serious complications have arisen. In some cases a fistula has formed, but in not more than one in every five or six cases has this occurred. The wound is usually completely healed after one week from the time of the second stage, so that only between two and three weeks are required, and a very small part of this period is spent in the hospital.

Fig. 295.—Roentgenogram showing site of diverticulum.

In the last twenty-two years (1907 to 1928 inclusive) 185 patients presented pharyngo-esophageal diverticula among approximately 939,000 registrants in the clinic. Practically all of the 185 were operated on for the diverticulum. Formerly it was sometimes necessary to do gastrostomy preliminary to the operation due to the fact that the patients came for treatment starved and dehydrated because they had not been able to take

sufficient solids or fluids. As already stated, we now have these patients swallow a strong thread, and using this as a guide we introduce a bougie or small tube into the stomach for feeding purposes. This can be accomplished with very little inconvenience to the patient and it carries a negligible risk compared to gastrostomy. As a matter of fact this is of so little inconvenience to the patient that as a rule we now introduce a small tube

Fig. 296.—Small stomach-tube in place. Second stage completed; wound practically healed.

into the stomach before operating and give all nourishment through this tube until the wound is entirely healed. Although this is not necessary when the diverticular sac is small and the patient is not emaciated and dehydrated, nevertheless we believe the tube should be utilized in every case following the second stage of the operation because it relieves the stress on the sutures and permits prompt healing.

# CORTICAL ABSCESS OF THE KIDNEY

E. Starr Judd and C. Baxter Brown

In 1919 W. J. Mayo discussed renal lesions and added to the old classification of Richard Bright a third or surgical type of hematogenous lesion. He emphasized the fact that there is a common form of true nephritis, differing from Bright's type 1 and type 2, which is caused by bacterial infection. Cabot and Crabtree demonstrated that foci of pus-forming cocci affect the renal cortex and extend along lines of least resistance outward, and that foci of colon bacilli affect the straight collecting tubules of the pyramids, extending from them to the pelvis and producing pyelitis. Mayo emphasized the fact that pyogenic infections lead to cortical abscesses and other evidences of disease visible to the eye; but that beyond a trace of albumin in the acute stage or the presence of a few pus and red blood-cells, the urinary findings are meager. In the subacute and chronic forms of pyogenic infection the kidneys may be destroyed or pyonephrosis may follow. The colon bacillus causes marked pyuria without the formation of abscesses. Finally, nephritis, which is the result of the presence of living bacteria, may involve the kidneys unequally or unilaterally.

Infection of the kidney from focal sources, after the theory advanced by Billings and further substantiated by Rosenow, has been shown definitely to be a large etiologic factor in focal suppurative nephritis, cortical abscess, and the septic infarcts of Brewer.[3, 4, 5] In reporting a series of experimental, pathologic, and clinical observations in abscess of the kidney, Brewer showed experimentally that anemia or passive hyperemia or injury to the kidney are predisposing factors favoring the formation of abscess when infection in the blood has been induced; and he produced lesions of the kidney with *Bacillus coli*, *Streptococcus*

*pyogenes*, *Staphylococcus aureus*, pneumococci, *Bacillus typhosus*, and *Bacillus pyocyaneus*. Of these, the first four have been reported to have been recovered in clinical cases. The most frequent source of infection appears to be the skin, although other foci are the nasopharynx, the teeth, the other kidney, the alimentary tract, and the bones in cases of osteomyelitis (Eisendrath and Rolnick). The cutaneous infections which cause remote lesions appear, further, to have a special affinity for the kidney as a secondary site. Phemister studied a series of nineteen cases of remote infections due to primary cutaneous lesions and found two cases of multiple renal abscesses and three of perinephritic abscess as against fourteen other miscellaneous lesions. Walther also emphasized the frequency with which renal suppuration is secondary to cutaneous lesions.

There is much evidence to show that cortical lesions of the renal parenchyma are chiefly blood borne. There is little reason to believe that ascending infection by way of the ureter is responsible for the clinical forms of suppurative nephritis. Brewer and others have reported experiments in which cultures have been instilled into the bladder in the presence of artificially induced urinary retention, but cortical lesions rarely have followed. Eisendrath, in reporting a case in which extension through the capsule of a cortical abscess, with resulting perinephritic abscess, was definitely established, emphasized the fact that there are three general routes by which organisms enter the kidney, renal pelvis, and ureter. These are the blood-stream, the lymph-stream, and the urinary tract. The lymphatic routes are two: the first is through the lymphatics of the ureter which connect with those of the bladder, prostate, seminal vesicles, and internal genitalia; the second is the direct communication between the lymphatics of the colon and those of the kidney, as demonstrated by Franke, thus permitting the organisms to enter the urinary tract without first passing through the blood-stream. Miller, in discussing the lymphatic connections of the kidney, emphasized the close relation between the cortical renal and the perirenal lymphatics, and between those of the lower part of the urinary tract and genitalia and the perirenal spaces. The

mass of evidence, however, from all sources and principally from clinical and experimental sources, points definitely to the bloodstream as the origin of suppurative nephritis in its several forms.

From the viewpoint of pathology, suppurative nephritis appears to be an embolic phenomenon occurring secondary to septicemia, endocarditis, phlebitis, and lesions of the skin, nasopharynx, and so forth. Presumably, infected thrombi attack the cortical substance of the kidney, causing a stage of hyperemia and hemorrhage followed by necrosis. Leukocytes gather around the disintegrating tissue, walling it off and producing an abscess. Although clinically the lesions appear in the cortex, it has been shown by Helmholz and Millikin that the first lesions produced experimentally by intravenous injection of bacteria appear in the medullary portion. In their experiments cortical lesions were not seen until forty-eight hours had elapsed after injection of organisms. Grossly, the cortex is studded with many small abscesses or it may contain only one larger abscess, which may have been the solitary lesion, or which may be the result of coalescence of adjacent smaller abscesses. Commonly the embolic type of lesion limits itself to the cortex, but it may extend deep into the medulla, and even to the pelvis, where it drains itself, producing the condition of pyelonephritis. It may, however, rupture through into the perirenal spaces. Braasch believes that 18 per cent of the cases of perinephritic abscess are caused by a preceding cortical abscess of the kidney. Hunt says, "Cortical abscess is probably the most common cause of perinephritic abscess. The experimental work of Brewer and others, as well as Rosenow's work on specificity of organisms, quite definitely establishes cortical abscess on a hematogenous etiologic basis. Clinical support of such a conclusion is the incidence of perinephritic abscess following the peripheral injections. . . . It has been proved that cortical abscess may follow superficial injection; and that it causes perinephritic abscess is supported by surgical and necropsy evidence." Hunt ascribes 46.3 per cent of perinephritic abscess to preceding cortical abscess. Cortical abscess may involve adjacent organs in its extension; abscess of the upper pole may perforate the pleural

sac, causing empyema, and abscesses in other places may cause peritonitis.

Clinically, one is impressed with the wide variation in symptoms in the different types of suppurative nephritis, depending on the degree of tissue resistance and the virulence of the organism. For convenience it may be said that there are three distinct types of the disease: fulminating, intermediary, and mild. In the fulminating type the patient may have fever, chills, pain, and tenderness in the costovertebral angle, nausea, vomiting, and leukocytosis. The urine will not contain pathologic elements, although the function of the kidney in severe unilateral lesions may be reduced. Renal insufficiency does not occur except in severe cases of bilateral disease, but in these types uremia may be terminal. Urographic evidence of disease usually is absent. Patients with the mild type are singularly free of symptoms of a general or localizing nature. Fever, slight lumbar pain, malaise, or anemia may be the only symptoms. In the intermediary types there are all degrees of evidence of pathologic processes.

The treatment of the different types varies with the severity of the disease. The severe fulminating type, when unilateral, requires nephrectomy as a life-saving measure. The intermediary type requires only nephrotomy or decapsulation; the milder forms respond to simple surgical drainage. Undoubtedly patients with mild infections recover spontaneously; likewise, some of the more severe cases resolve spontaneously following rupture of the abscess into the renal pelvis. In most cases in which cortical suppurative nephritis or abscess is primarily the cause of perinephritis, the operation of simple drainage relieves the symptoms. On the other hand, cortical involvement also accounts for the intractable perinephritic abscess which requires eventual secondary nephrectomy for the relief of the symptoms.

## REPORT OF CASE

The patient, a boy aged eleven years, was brought to the clinic November 8, 1928. He had had measles and several annual attacks of influenza. In May, 1928 he had had an attack of what had been thought to be pleurisy because he had complained of a "catch" in the chest on deep breathing. There

had been slight fever, which had subsided in a few days. Thereafter the patient had had attacks of fever rising as high as 103° F. in the afternoon, lasting for periods of several weeks, and then subsiding for several weeks. During the attacks the patient had been pale, weak, and had required aid in walking and dressing. The last attack had begun three weeks before he came to the clinic and had ended ten days later. He had improved rapidly thereafter, although there had been a slight afternoon rise in temperature during the week previous to admission.

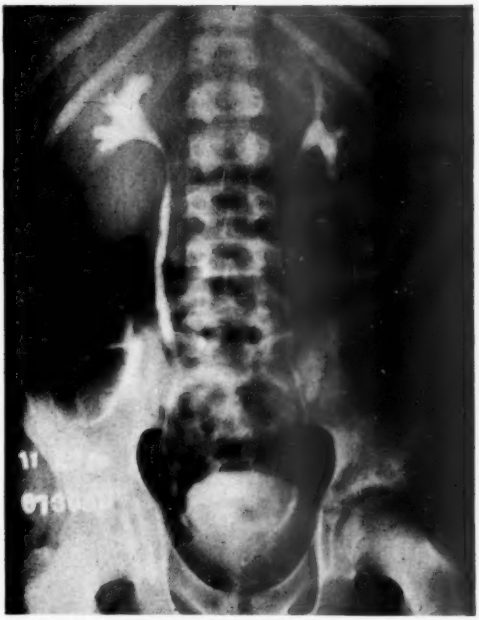

FIG. 297.—Bilateral pyelogram showing increased size of shadow of soft tissue at the lower pole of the right kidney and evidence of compression of the right ureter in the upper 2 to 3 cm.

General examination revealed that the boy was pale and slightly undernourished. He weighed 65 pounds. The pulse-rate was 100 beats a minute and the temperature 98.6° at noon. The systolic blood pressure varied from 90 to 98 mm. of mercury, and the diastolic, from 44 to 60 mm. There was definite but slightly increased resistance of the right lumbar muscles. The throat, nose, and ears appeared normal. Roentgen-ray examination of the accessory nasal sinuses revealed slight cloudiness of the left maxillary antrum, but signs of active sinusitis were not found.

The urine on repeated examination was free of albumin, sugar, blood-cells, and bacilli of tuberculosis, but at several examinations there were occasional pus cells in the centrifuged specimen. Culture of urine from the bladder, made on brain broth and blood agar, disclosed a growth of hemolytic streptococcus. This result could never be repeated with subsequent cultures of urine from the bladder or with catheterized ureteral specimens. The hemoglobin was estimated at 60 per cent; there were 3,860,000 erythrocytes and 11,000 to 14,000 leukocytes in each cubic millimeter of blood. The differential leukocyte count was as follows: Neutrophils 76.5 per cent, lymphocytes 19 per cent, and transitional cells 4.5 per cent. Agglutination reactions for the typhoid bacillus, *Bacterium alcaligenes melitensis*, and *Bacterium alcaligenes abortus* were negative. Repeated blood-cultures were negative.

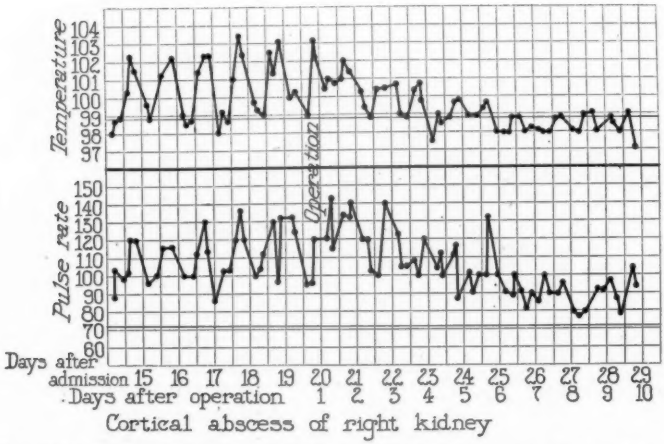


FIG. 298.—Temperature chart showing septic type of fever with gradual fall to normal following surgical drainage of solitary cortical abscess.

The von Pirquet and Mantoux reactions were negative. The blood urea was 23 mg. for 100 c.c. of blood. Roentgen-ray examinations of the chest, kidneys, ureters and bladder, and mastoid areas were negative. The renal function, as estimated by the output of phenolsulphonephthalein in bladder urine, was 85 per cent.

On cystoscopic examination, November 23, the bladder appeared normal. Ureteral orifices were normal and clear urine spurted from them at regular intervals. Specimens and cultures from each side were negative for pus or bacteria. Bilateral pyelograms were made. The right pyelogram revealed that the pelvis and calices were normal (Fig. 297). There was the outline of an unusually large mass of soft tissue with bulging into the upper 2 or 3 cm. of the ureter, suggestive of pressure from a cyst. The remainder

of the ureter was apparently normal. In the left pyelogram the pelvis, calices, and ureter were seen to be normal. The cystoscopic diagnosis was indeterminate, but the possibility of a pathologic process in the right kidney was not excluded.

During nineteen days of observation in the hospital the patient was confined to bed. There were no complaints. The temperature during this time was septic in type, normal in the morning and from 101.6° to 103° F. in the afternoon (Fig. 298).

November 29 the right kidney was explored through a posterior incision. There was an abscess of the lower pole of the kidney and edema of the perirenal tissues, but all pus was contained within the capsule of the kidney (Fig. 299). The abscess was incised and about 75 c.c. of thick, yellow odor-

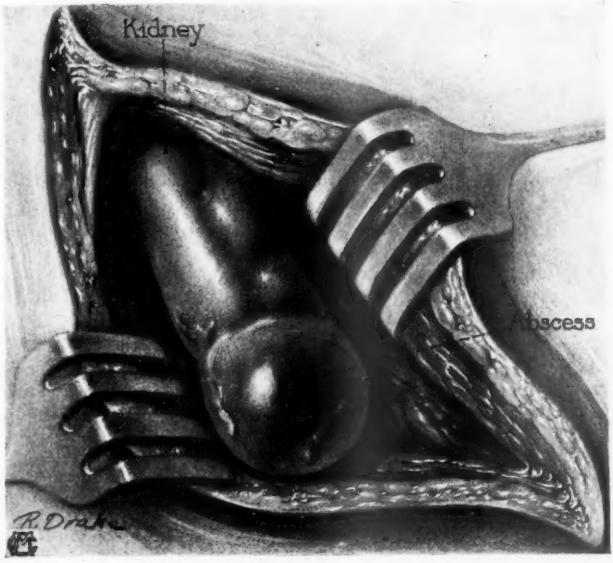


FIG. 299.—Sketch of kidney showing large cortical abscess at lower pole.

less pus was removed. A split tube drain was left in the abscess cavity. The kidney apparently was in good condition, although it was felt that it might have to be removed later. Cultures from the pus revealed *Streptococcus hemolyticus* and staphylococci.

The patient's recovery was uneventful. The fever gradually subsided and the wound healed. He was dismissed from observation December 29.

## COMMENT

This case is reported because it is an excellent example of the mild type of renal suppuration which produces a minimum of symptoms and runs a typhoid-like course. Although the primary focal lesion is somewhat obscure, it is probable that a slight nasopharyngeal lesion was responsible. The most striking feature of the case was the fact that definite abnormalities were disclosed by urography. Recovery of the streptococcus both from pus and from urine of the affected kidney is interesting.

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# A COMBINED OBLIQUE AND TRANSVERSE SKIN INCISION IN OPERATIONS FOR INGUINAL HERNIA

WALTER E. SISTRUNK

SINCE 1915 I have used a skin incision in operating for inguinal hernia which has proved very satisfactory. This incision has been extensively used by various surgeons in The Mayo Clinic and at one time it was reported by Rankin.

This incision is a combination of the ordinary oblique incision so frequently used in operations for inguinal hernia and of the transverse incision which has been advocated in such operations. It is made from a point about 2.5 cm. to the inner side of and just below the anterior superior spine of the ilium; it is carried

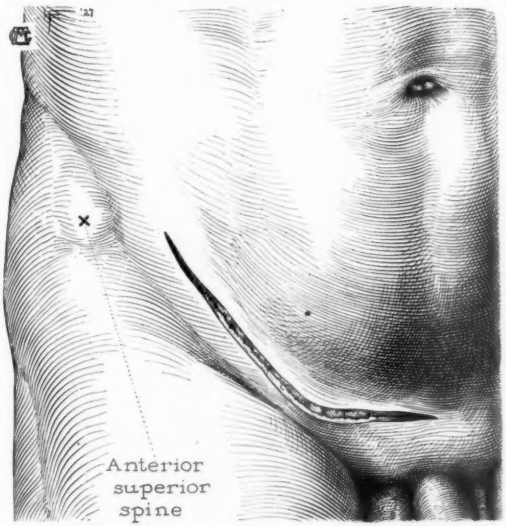


FIG. 300.—Combined oblique and transverse skin incision for operation on inguinal hernia.

downward as the ordinary oblique incision for a distance of about 6 cm., where it is curved inward and made to extend to the median line just at the top of the pubic bone (Fig. 300). All of the subcutaneous tissues down to the fascia are divided from the top of the incision to the median line.

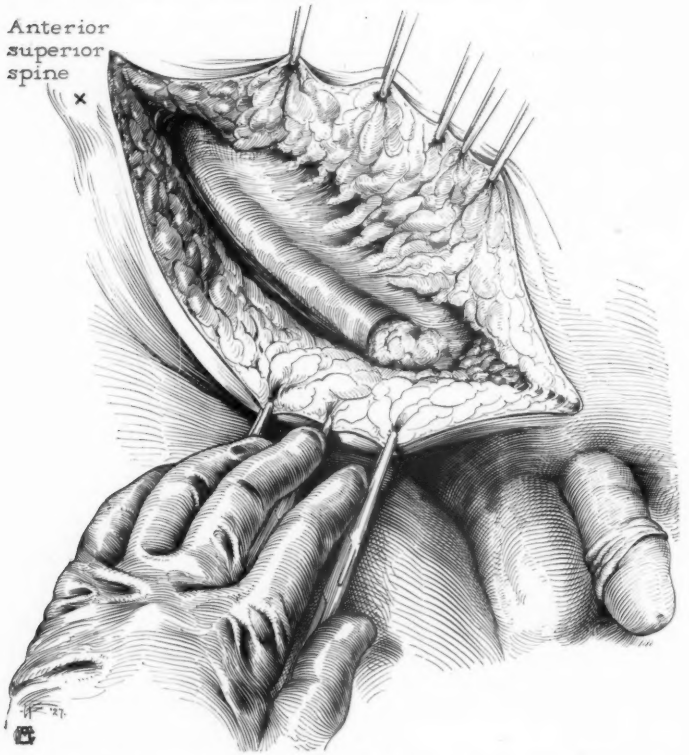


FIG. 301.—Flap retracted and external abdominal ring exposed, giving wide exposure.

Such an incision gives excellent exposure of the external abdominal ring and very little retraction is necessary, even in stout persons, to obtain exposure of the desired area (Fig. 301). The incision is high and does not extend down on the scrotum;

for this reason it may be kept more carefully covered after operation. It has seemed to me that the incision heals more satisfactorily than the usual oblique incision.

After the herniotomy has been completed three silkworm-gut sutures are generally introduced through the skin and subcutaneous fat. Each of these is passed through the fascia of the muscles in order to prevent pockets as much as possible. These sutures divide the wound into three equal parts. A few interrupted dermal sutures or horsehair sutures are then used to complete the closure.

# EPITHELIOMA OF THE LIMBUS

WILLIAM L. BENEDICT

OF the neoplasms found about the eyeball, epithelioma of the limbus is one of the most common. It is usually a primary lesion situated at the nasal or temporal margin of the cornea in the palpebral fissure, but it may appear secondary to epithelioma of the lids. Multiple nodules may be present, but the growth more often begins as a solitary nodule on the conjunctival side of the limbus, then extends up and down along the limbus, and spreads through the cornea and the conjunctiva. The vascularization varies from one or two vessels clearly visible in the conjunctiva to a network of vessels in a deeply congested and thickened conjunctiva involving the deeper layers. The rapidity of growth is variable in all types of epitheliomas of the limbus, but the most vascular appear to grow more rapidly after the surrounding tissues become involved in the congestion. Since it appears more frequently in men than in women it may be surmised that exposure and trauma play a part in the progress of the growth as it also does in the origin. The head of a pterygium may be the site of an epithelioma. I do not believe, however, that the presence of a pterygium in any way predisposes to the development of epithelioma, nor do the benign papillomas, sometimes seen about a pterygium, often develop malignant characteristics. On the other hand, a slowly growing epithelioma at the nasal limbus may not be differentiated without microscopic examination of the tissue. It is always safe to take tissue for diagnosis. Every suspected growth in the region of the limbus should be examined microscopically.

Whenever there is a transition in the type of epithelium, as is found at the limbus, the margin of the lid or the vermilion margin of the lip, epitheliomas are more common. Carcinoma of

the skin, in many instances similar in structure to epithelioma of the lid or limbus, is often found, however, about the face or ears of the same patient, while less frequently carcinoma of the thyroid gland or other glands may be found.

Epithelioma of the limbus as a primary growth, or secondary to epithelioma primary on the margin of the lid, is more common among men than women. An instance of primary epithelioma of the limbus has not been found in women in The Mayo Clinic. It is seldom ever found in men aged less than forty years. The occurrence of tumors in the palpebral fissure indicates that exposure and trauma have much to do with their origin. This is further substantiated by the history of the onset of the growth. The development of an epithelioma within a few weeks after injury to the globe was noted in several cases in the clinic. With attention directed to the eye by the injury there is little likelihood that the growth had been present longer than for the period indicated; the microscopic examination of the tissue confirmed the diagnosis. Epitheliomas may become as large as 1 cm. in diameter within three weeks after they first appear.

After a minor injury a small red spot appears near the limbus to which the patient's attention is attracted and from which after a few weeks or months a rapidly growing granular mass develops which becomes vascularized from conjunctival vessels. The growth is painless except that there is a feeling of a foreign body in the eye. The mass of tissue piles up at the limbus and rolls over on the cornea farther than it invades the substantia propria, so that the portion of the cornea not covered is clear instead of being infiltrated, as in inflammatory lesions.

Ulceration seldom occurs. Occasionally, however, deep marginal ulceration of the cornea with nodular hypertrophy and deep congestion of the adjacent conjunctiva are seen which bear a marked resemblance to Mooren's ulcer. Such ulcers do not respond to treatment, but continue to spread over the cornea and conjunctiva. There is considerable vascularity and thickening of the bulbar conjunctiva and canthus so that it is difficult to outline the peripheral extent of the growth. Although there is little pain about the eye, there is constant lacrimation and

annoying photophobia. The ulcer does not heal after curetment and application of strong chemical cauterization. If the tissue is pared away and the area covered with a conjunctival flap, there is likely to be a return of the growth with more malignant characteristics. This ulcerating chronic type of tumor is most frequently seen at the lower nasal quadrant of the limbus and it spreads toward the temporal side by way of the lower part of the cornea.

Multiple epitheliomas do not often appear, the solitary nodule being the type most often found. Among the cases reported here there was none with multiple lesions at the limbus. Approximately four out of five are of the raised pale granular type, rapidly growing, with a flat, thin, vascularized zone of conjunctiva surrounding it. Extension of the tumor is usually along the surface of the globe. Rarely it penetrates to the interior at the limbus. It never invades the globe at any other place. Metastasis posteriorly is rare, the orbit usually being invaded by direct extension posteriorly. Secondary tumors on the margin of the lid may develop from a primary tumor on the globe. In contradistinction to primary epitheliomas of the lid which are most often of the basal-cell type, epitheliomas of the limbus are nearly all of the squamous-cell type. They are of low-grade malignancy, only slightly more so than basal-cell epitheliomas. It would appear that a squamous-cell epithelioma primary at the limbus is less likely to produce metastasis; in other words, it is less malignant than a squamous-cell epithelioma of the lid.

Most cases of epithelioma of the limbus are of short duration. The appearance of the red spot on the eye and the course and development of the growth attract attention early, and it is carefully watched and treatment sought. The growth seems to be accelerated by irritants, such as iodin, carbolic acid, zinc chlorid, uviol light, and small doses of radium. Simply cutting away the mass is of little help, and if the area is covered by a conjunctival flap a recurrent growth may be hidden until it becomes so large that it is difficult to deal with it by any means. The most effective means of destroying the growth with the

greatest safety to the eye is by fulguration. If properly carried out, this treatment is usually sufficient for permanent cure. There is very little reaction or pain following the fairly extensive cauterization of the cornea and episcleral tissues. The solid granular type of growth should be pared away together with the infiltrated portion of the cornea and conjunctiva to the sclera and the denuded area fulgurated. The soft ulcerated type of growth should not be cut away except as a portion is needed for microscopic examination. The wound should be left open to fill in from the sides; it will be covered finally by a smooth scar. Radium may be applied a few days after the operation to take care of the deeper tissues that may contain some carcinoma cells. The following case records are given as examples of the various types seen and the treatment described.

## REPORT OF CASES

**Case I.**—A man aged fifty-nine years was examined May 10, 1918. He had had a growth on the nasal side of the limbus one year previously. There was marked scarring of the conjunctiva from trachoma. On the left eye there was a mass rising from the ocular conjunctiva at the limbus nasally and extending over the nasal half of the cornea. The cornea was otherwise clear. The vision of the right eye was 6/12; of the left eye, 6/60. From May 15 to May 25 he received a total of 250 milligram hours of radium with lead, copper, and rubber protection. July 29 all evidence of epithelioma had disappeared from the cornea. There remained only a faint roughness of the conjunctiva near the limbus, while over the cornea where the tumor had been there was slight vascularity and infiltration.

**Case II.**—A man aged fifty-eight years was examined September 23, 1919. He had noticed for the last six or seven years a red spot at the temporal margin of the cornea of the left eye when suffering from a cold. Seven months before this examination he noticed a small growth at this spot which grew rapidly. Vision of the right eye was 6/6–1; of the left eye, 6/10–1. The tumor measured 1 mm. horizontally and 8 mm. vertically. Situated over the limbus on the temporal side it extended an equal distance over the cornea and sclera. It was soft with a rather large central sloughing area elevated about 4 mm. at the highest point. It extended over the cornea to within 2 mm. of the anterior pole covering the limbus from 2 to 5 o'clock. There was marked injection of the upper conjunctiva, vessels running from the mass in two leashes, one almost straight down and the other toward the inner canthus. The pathologic diagnosis was squamous-cell epithelioma. The patient was treated with 200 milligram hours of radium. He was not heard from further.

**Case III.**—A man aged fifty-eight years was examined November 17, 1919. Vision of the right eye was 6/20; of the left eye, 6/12. About five or six weeks previously the patient noticed a small growth in the inner angle of the left eye near the limbus. This had grown rapidly causing irritation and lacrimation. The lids and conjunctiva were clear except for hyperemia; the bulbar conjunctiva was congested over the temporal side. There was a pale granular mass 1 cm. in diameter at the temporal limbus encroaching on the cornea about 4 mm. (Fig. 302). The cornea was otherwise clear. The mass was hard, round, finely granular, and not deeply congested, although there was considerable injection of the conjunctiva at its base. The pathologic diagnosis was squamous-cell epithelioma, graded 2.

FIG. 302.—(Case III.) Primary squamous-cell epithelioma of the left eye.

November 10 to 15, inclusive, a total of 250 milligram hours of radium was applied over the tumor. January 2, 1920, the vision of the left eye was 6/15–1. There was a mass on the globe extending to within 3 mm. of the anterior pole of the cornea from the direction of 2 o'clock extending backward in a crescentric form, almost to the outer canthus. It was elevated 3 to 4 mm., was spongy, firm, covered with a slight exudate, and pale pink. The cornea was not infiltrated beyond the margin of the growth. January 6 cautery was applied around the margin of the tumor and the mass excised to the sclera. The wound healed without complications. From January 12 to 19 inclusive, following operation, 400 milligram hours of radium was applied to the left eye. January 24 vision of the left eye was 6/12–1. There was no sign of epithelioma and the patient was comfortable. May 18 he returned to the clinic. The palpebral conjunctiva, especially of the upper lid, was considerably inflamed and thickened and there was mucopurulent secretion in the conjunctival sac. On the upper temporal margin of the cornea was a white, elevated mass with a granular surface extending from 12 to 2 o'clock. The mass was elevated about 1 mm. To this growth ran some large vessels,

but otherwise the conjunctiva was clear. Two hundred milligram hours of radium were again applied to the mass and the patient instructed to return in a month. June 17 and 18 he was given 400 milligram hours of radium. He returned July 16 with a recurrence of the tumor at the upper outer quarter of the cornea about 12 to 2 o'clock. This was slightly elevated, and encroached on the cornea about 3 mm. It also extended down over the cornea to meet with another mass at 4 to 6 o'clock. This mass was elevated about 1 mm.; the surface, finely granular and pale pink, reached by a leash of vessels coming through the conjunctiva from the upper portion of the globe. July 16 to 19 100 milligram hours of radium were applied. Further record in this case was not obtained.

**Case IV.**—A man aged forty-three years was examined April 21, 1920. Vision of the right eye was 6/7, of the left 6/12. The patient came to the clinic because of a growth on the left globe of three years' duration. This growth started from an injury, the eye being struck by a nail, later by a piece of wood. Following the latter injury the eye was red for a few days and then became clear. There were periods of redness during the next year but a growth was not noticeable until a year previous to this examination, since

FIG. 303.—(Case IV.) Primary squamous-cell epithelioma of the limbus before treatment.

which time the growth had progressed steadily. At the limbus on the temporal side of the left eye there was a large raised, red growth, covering the entire temporal half of the cornea and extending a few millimeters over on to the conjunctiva (Fig. 303). The growth was very vascular and firmly adherent to the globe. There were both superficial and deep vessels reaching to the mass. The lower margins showed increased pigmentation.

A specimen removed for biopsy was diagnosed squamous-cell epithelioma. The epithelioma was excised and the bleeding points cauterized. The wound

was not covered with conjunctiva. Following the removal of the tumor 100 milligram hours of radium were applied. The wound healed cleanly. The area occupied by the tumor was covered with scar tissue and May 15 the patient was dismissed with vision equal to 6/7. He was advised to return later for further radium treatment (Fig. 304).

The patient was seen again September 9, with slight vascularization over the limbus at 3 o'clock, but without signs of tumor. At the upper margin of the lid of the outer canthus, however, was a small growth 2 mm. in diameter; this was destroyed by carbolic acid. Since biopsy was not made, it is not certain that this was an epithelioma.

FIG. 304.—(Case IV.) Primary squamous-cell epithelioma of the limbus after treatment.

January 21, 1921 the patient returned because of recurrence of the growth in the upper margin of the left lid. The epithelioma had not recurred at the limbus. There was a slight scar in the cornea temporally at the site of the epithelioma, the conjunctiva growing over the limbus to this scar. At the upper limbus there was a small area of gelatinous infiltration about 2 mm. in diameter slightly vascularized. In the upper lid about the juncture of the middle and outer third was a flattened polypoid growth about 5 by 4 by 1 mm. with a linear pedicle attached at the margin of the lid.

The growth, a benign granuloma, disappeared with the application of a small amount of radium. The patient died in October, 1921 of carcinoma of the thyroid gland.

**Case V.**—A man aged thirty-six years was examined June 19, 1924. The vision of the right eye was 6/10+2, of the left eye 6/6+3. The patient

stated that the right eye had been normal until two weeks previously, when it had been hit by a bug. That night a small papule developed in the conjunctiva a few millimeters from the limbus at 4 o'clock. This mass grew rapidly. It was not painful, but it gave the sensation of a foreign body in the conjunctiva. The palpebral conjunctiva of the right eye was only mildly injected; the ocular conjunctiva was slightly more injected, particularly on the nasal side. At the nasal limbus there was a rounded mass in the conjunctiva, measuring 6 mm. in diameter, with an elevation of about 5 mm., and a marginal ulcer of the cornea adjacent to this mass which stained with fluorescein.

The ulcer was removed and 29 milligram hours of radium were applied. The pathologic report was squamous-cell epithelioma, graded 2. July 5 the vision of the right eye was 6/5. The eye was quiet and the area from which the tumor had been removed was healed, showing a small vertical scar about 3 mm. in length. Further records were not available.

**Case VI.**—A man aged forty-eight years was examined August 20, 1925. He came to the clinic because of a red spot on the right globe which was first noticed one year previously and had gradually increased in size. Vision of the right eye was 6/7, of the left 6/6. The right palpebral conjunctiva showed considerable congestion. At the nasal margin of the cornea was a reddened elevated granular mass, extending 2 mm. on to the cornea and 4 mm. on to the sclera. Pathologic examination was not made.

Six hundred milligram hours of radium were applied over the area on the right eye and five weeks later 700 milligram hours were applied over the same area. The patient was next seen November 5. The vision of the right eye was 6/6–2. From 2 to 5 o'clock there were three white, raised areas, from 3 to 4 mm. in diameter, with a thin web of vessels leading from the limbus to the inner canthus. The tumor was too vascular for satisfactory biopsy but was removed by means of a monopolar desiccating method under local anesthesia.

February 17, 1926 the eye was greatly improved. There was a small, grayish area near the limbus with slight vascularization of the conjunctiva in this neighborhood. Further treatment was not deemed necessary. The patient died in April, 1926 of influenza. At the time of his death it was reported the eye was entirely healed.

**Case VII.**—A man aged seventy-two years was examined May 6, 1925. Vision of the right eye was reduced to ability to count fingers; of the left eye to 6/60. An internal squint of the right eye had been present many years, following an injury by a piece of wood. Eight months previous to coming to the clinic the right eye was injured by a corn blade. Three weeks previous to coming to the clinic the right eye became red and a small mass appeared at the limbus. The palpebral conjunctiva of the right eye was normal, but on the limbus at 3 o'clock was a small flat growth, freely movable, in the conjunctiva over the sclera. It was roughly triangular in shape with the base directed toward the canthus where it was about 8 mm. in size.

The mass was removed by surgical diathermy. October 20 the patient returned. The area previously treated appeared to be healed. Fifty milligram hours of radium were applied to a small button in the sclera, which did not seem to be a part of the original process.

**Case VIII.**—A man aged thirty-seven years was examined July 31, 1926. Vision of the right eye was 6/7, of the left 6/6. Three weeks previously, while he was driving, the right eye had been struck by a bug; pain and redness followed, but disappeared the next day. One week later his attention was called to a small growth on the right eye near the cornea, and two small, swollen areas were seen on the nasal side of the globe; these gradually became larger and fused into one mass. There was an elevated area just nasal to the limbus about 4 mm. in diameter, elevated about 2 mm. This was granular and slightly pink. There were many blood-vessels leading to the area through the conjunctiva; the eye appeared normal otherwise. The mass on the limbus was cauterized with trichloracetic acid. Three weeks later the mass had disappeared and the wound was healed. Biopsy was not made.

**Case IX.**—A man aged forty-eight years was examined April 2, 1928. The vision of the right eye was 6/6–3, of the left 6/6–1. A small mass had appeared near the limbus on the nasal side of the left eye three weeks previously. When the patient first noticed the growth it was white and smaller than a pinhead. It grew rapidly. Ten days previous to coming to the clinic it became inflamed and there was increased vascularization in the tissue about it. At the nasal portion of the limbus there was a fleshy mass 1.5 by 3 by 5 mm. Otherwise the conjunctiva and the cornea were clear.

The mass was carefully cut away and the area cauterized with an electric cautery; the wound in the conjunctiva was not closed. A diagnosis was made of squamous-cell epithelioma, graded 1. Recurrence has not occurred.

**Case X.**—A man aged fifty years was examined August 16, 1928. Vision of the right eye was 6/10–2, of the left 6/5–2. For ten years there had been a very small elevation at the nasal margin of the cornea of the right globe. There was little change in the size of this mass until two months before he came to the clinic, when he noticed it was growing rapidly. Examination showed a large, cauliflower-like mass on the right eye reaching to the inner canthus and extending on to the cornea nearly covering the nasal half (Fig. 305). It was elevated almost 12 mm. at the highest point, was slightly pink, and was covered with a frothy secretion. The cornea was not infiltrated beyond the margin of the growth; the chamber and iris were not involved.

The mass was excised carefully with a sharp knife and separated from the sclera and cornea. The area of the cornea that was involved as well as the conjunctiva and sclera were fulgurated and the wound left open. The pathologic diagnosis was squamous-cell epithelioma, graded 2. The area healed with very little reaction. October 8 vision without correction was 6/30+1. A small band of adhesions extended from the nasal end of the lower fornix to the limbus, but this did not interfere with motion of the eye.

The area on the globe was entirely healed over with conjunctiva, slightly thickened and injected but healthy in appearance; there was slight cloudiness of the cornea in the area covered by the epithelioma and treated by fulguration.

FIG. 305.—(Case X.) Primary squamous-cell epithelioma of the limbus, graded 2. This large growth was cleanly pared away and the area fulgurated.

## COMMENT

The advantage of the surgical removal of these tumors followed by fulguration over other methods of treatment lies in the rapidity of the process. Several months are required to complete a course of treatment with radium or roentgen rays if used alone, while the healing after fulguration requires only a few days to a few weeks. Antiseptic solutions and ointments are used during the convalescence, and infection is not greatly to be feared. The absence of pain and deep congestive reaction following fulguration makes it particularly desirable whenever it is possible to use it. As it is practically impossible to remove or to destroy with the cautery all the outlying carcinoma cells, the use of radium or roentgen rays is almost imperative. With proper protection this treatment can be carried out without harm to the lens or other structures within a week or two after the operation. For the ulcerative marginal epitheliomas fulguration alone may suffice, but, if the means are at hand, it seems wise to provide further protection against recurrence.

# THE PHYSIOLOGY OF CARDIAC RESUSCITATION

J. Markowitz and Frank C. Mann

We propose to demonstrate this afternoon two of the more usual physiologic methods which embody in them the principles underlying resuscitation of a recently quiescent heart. The underlying principles of these experiments are directly applicable to the treatment of a collapsed patient during an operation.

Among the laity and even occasionally among the medical profession there is a view that the heart is an extremely delicate organ and requires but little trauma to be incapacitated. As the following experiments will show, this is absolutely not the case for the healthy heart. Usually in the operating room failure of the circulation is peripheral and not cardiac in origin, although cases of sudden death occurring in the induction stage of anesthesia are probably the direct result of ventricular fibrillation, as Levy of England has shown. Such cases are now fortunately rare, owing to the general disuse of chloroform as an anesthetic in this country; and probably one is safe in generalizing that circulatory failure during an operation is a vasomotor failure, with failure of the heart beat secondary to this. In cases of heart disease, of course, the cause of failure may be primarily cardiac. In the physiologic operating room we are in the habit of continuously recording the animal's blood-pressure during prolonged or severe operations, and by watching the general trend of the blood-pressure curve we receive ample warning when impending circulatory failure is at hand. Thus, we manage to save the animal by the timely administration of hypertonic solutions of glucose and sodium chlorid, by solutions of gum acacia, or by a blood transfusion. This technic, although troublesome in the sense that it consumes extra time, has been found by us to be very valuable as regards mortality. When an animal is in a state

of shock it is much more difficult to restore its blood pressure than it is to prevent the occurrence of shock by adding bulk to the circulation. This is due to the fact that the centers in the medulla are easily injured by a low blood pressure, so that a vicious circle is readily set up. The low blood pressure injures the vasomotor centers on the medulla, and these in turn fail to maintain tonic constriction of the blood-vessels all over the body, so that the blood pressure falls even farther, and a vicious circle which is extremely difficult to break becomes established. In order to resuscitate an animal whose peripheral resistance has suddenly opened up, the immediate need is for the replacement of fluid which is stagnant in the periphery so that the heart may have something to contract on and thus maintain the blood pressure. In order to resuscitate a heart which has failed either primarily from the anesthetic or secondarily from low blood pressure, the urgent need is slightly different, as the following experiments will show.

On the table before us is a rabbit under ether anesthesia. The ether is being supplied by a current of compressed air which is rhythmically interrupted so as to allow the lungs to deflate by their own elasticity. Since we do not intend to keep the rabbit we have for the sake of convenience inserted a tracheal cannula. We are bleeding the animal to death by exposing the abdominal aorta and vena cava. The animal is now practically dead. We are opening its thorax and the auricles may still be seen beating and the ventricles giving an occasional beat. Now the heart is almost completely quiescent, and we are going to excise it, taking precautions not to injure the auricles and to leave a long strip of aorta. Although we are handling the heart carefully, it is obvious that it is receiving a considerable amount of trauma in the process of being removed from the body and being placed in a beaker of cold Ringer-Locke's solution. This heart has now been dead for about five minutes; it could be readily resuscitated even after one hour.

The prime essential in resuscitating a quiescent heart is to secure suitable intracoronary pressure. It is immaterial whether the intracoronary pressure is produced by blood, sodium chlorid

or even by compressed air, liquid paraffin, or mercury; the introduction of any of the foregoing agents into the coronary artery under pressure will be followed by the resumption of the heart beat. Of course, if the heart is to be resuscitated permanently one must use a nutrient solution like blood or oxygenated Ringer-Locke's solution, but we wish to emphasize that pressure *per se* is the essential factor. We shall wash this heart thoroughly with cold Ringer-Locke's solution to get rid of blood-clots, and then rinse the aorta with a few jets of Ringer-Locke's solution from a syringe. We shall wash blood from the coronary arteries by clamping the aorta around the nozzle of a syringe thus with our fingers. The heart, as may now be seen, is quite bloodless. We attach the heart to a cannula containing warm oxygenated Ringer-Locke's solution at a pressure of about 100 cm. of water. By tying the aorta onto the cannula, the fluid backs up against the semilunar valves which are closed, and the fluid thus gets into the coronary arteries under suitable pressure. Even now the heart is already beating irregularly and it may be noted that the beats become more and more coördinated. In about fifteen minutes the heart will beat regularly and forcibly at about its usual rate. Such a heart will beat for many hours quite regularly.

The next experiment will illustrate the application of this principle in the resuscitation of a dog which we shall asphyxiate. The dog is under ether anesthesia which is induced by tracheal intubation. It is an easy matter to intubate the trachea of a dog, and we have taken advantage of this by administering all anesthetics in this way. In this particular experiment the anesthetic is supplied in the same way as in the rabbit: by passing compressed air through an ether bottle, the compressed air being rhythmically interrupted about forty times a minute. It should be stated that in order to get the best results the compressed air should be offered to the lungs at a positive pressure of about 15 mm. of mercury. The animal's blood pressure is being recorded on smoked paper with a cannula in the carotid artery. We are clamping the trachea. The animal is fully anesthetized and cannot feel pain. It may be noted that the blood pressure

immediately begins to rise and that the respiratory oscillations of the blood pressure tracing are becoming exaggerated. It may be also noted that the heart rate, as indicated by the number of joggles in each curve, is becoming somewhat slowed. This slowing of the heart rate is due to stimulation of the vagus center in the medulla by the asphyxia. If we were to cut the vagi or to give atropin the slowing would not occur, and the blood pressure would rise to a much higher level. This slowing of the heart rate is a conserving mechanism and is of distinct benefit to the organism since every minute of life under conditions of asphyxia gives the organism that much more chance to relieve itself of the obstruction. The high blood pressure during this initial phase of asphyxia is also due to anemia of the medulla; in fact, an easy way of producing elevated blood pressure in an animal is the production of a mild degree of asphyxia. The blood pressure is now beginning to fall from secondary failure of the heart. We are now opening the chest by a lateral incision between the fifth and sixth left ribs. The heart, especially the right side of the heart, is extremely dilated and cyanotic. The blood pressure is practically zero. The ventricles are giving an occasional pulsation and the auricles are pulsating more often; that is to say, heart-block is a common manifestation of asphyxia of the heart. If it were not for the fact that it would spoil the experiment we would demonstrate the beneficial effects of puncturing the right auricle or the vena cava adjacent to the heart, in which case marked improvement in the heart would be manifested. Clinically, of course, this has its analogy in the occasional striking benefit which results in impending failure of the right side of the heart from brisk venesection. The heart is now completely quiescent and the blood pressure is zero. If this were a patient you would have no hesitation in pronouncing him dead. We shall now remove the clamp from the trachea and revive the animal. The method which we are demonstrating is essentially that worked out by Crile. We are resuming artificial respiration by intratracheal insufflation, and shall inject into the arterial blood-stream through a cannula in the opposite carotid a solution of 1 : 50,000 epinephrin. It will take about 200 c.c.

of this to revive the animal. The epinephrin causes intense constriction of all the arterials peripherally. The reservoir containing the epinephrin is about 1 meter above the left ventricle. Usually the heart begins to beat when about 100 c.c. of the solution has been injected. We repeat that the essential factor in resuscitating a heart is the development of suitable intracoronary pressure. The blood pressure is beginning to rise a little and the heart, on inspection, is giving an occasional beat. By applying the hand to the heart directly and compressing it gently, it will give a vigorous beat. It is not necessary to do this directly to the heart; usually traction on the overlying wall of the chest will bring about the same results. Every time the heart beats it raises the blood pressure in the aorta. The peripheral resistance, on account of the epinephrin, is so great that even a feeble beat causes a considerable rise in blood pressure. Of course this establishes a benign circle. Every time the heart gives a beat it raises the intracoronary pressure and facilitates the spontaneous occurrence of subsequent beats. We are fortunate today in that the heart is recovering its rhythmicity rapidly. The blood pressure is already distinctly above normal and the right side of the heart is relieved of its engorgement. An intravenous transfusion should be given now if we wished to save the animal. Previous to this point an intravenous transfusion would have been harmful. If the blood pressure is zero an intravenous transfusion only rarely resuscitates a heart. If the blood pressure is low an intravenous transfusion usually resuscitates a heart, but the surest way to resuscitate a failing heart is to give an intra-arterial transfusion of such a nature as to bring about physiologic intracoronary pressure.

Occasionally a dog like this will recover completely, although mentally it is never normal. After an animal has been "dead" for ten minutes or so the medullary centers may be revived so as to function normally, but the cortical centers will remain permanently injured.

We wish to emphasize that our remarks apply only to a healthy heart that is failing because of low intracoronary pressure. By means of Starling's heart-lung technic or by means of

Carrel's visceral organism preparation, we could easily demonstrate that a normal heart will invariably fail when the intracoronary blood pressure is below 70 for approximately half an hour. In these preparations we can easily arrange matters so that the heart receives its normal quantity of blood to expel and so that the only variable is the intracoronary pressure.

# THE SPECIFIC DYNAMIC ACTION OF FOOD

CHARLES M. WILHELMJ AND FRANK C. MANN

MODERN surgery is rightfully placing more and more emphasis on the proper preoperative and postoperative care of surgical patients. The degree of risk incurred in any operative procedure is in a large measure dependent on the nutritional condition of the patient at the time of operation, whereas the postoperative recovery is to a great extent governed by the ingestion and utilization of proper food. We are all familiar with low degree of resistance to infection and the inability to withstand operative procedures which characterize the patient with severe diabetes. We are also familiar with the striking changes which have occurred since the introduction of insulin therapy. The low resistance of the diabetic patient is dependent, in a large measure, on the inability of the body to utilize carbohydrate. Experimentally, the same low resistance can be produced in normal animals by the use of phlorizin, a drug which increases the permeability of the kidneys to sugar, and draws carbohydrate away from the body so rapidly that little or none of it can be utilized. Persons in perfect health are ordinarily not conscious of the great increase in metabolism and subsequent strain on the heart and vascular system which follows the ingestion of a large meal; the frequency of sudden death in cases of hypertension and cardiac disease following the ingestion of a large meal is, however, adequate proof that the invisible work of the body is greatly increased by the ingestion of food. The experience of explorers and professional "fasters" is in accord with experimental evidence in showing that the ingestion of protein, following a period of total fasting, is often accompanied by toxic manifestations of great severity, which can to a large extent be prevented by the previous ingestion of carbohydrate. If the surgeon is to control

and make use of dietary regulation, it is essential that he be familiar with the nature of the fundamental reactions which take place when food is utilized by the body.

There is marked and prolonged elevation of the basal metabolic rate following the ingestion of any one of the three primary food-stuffs (protein, carbohydrate, and fat). Rubner, the German physiologist, termed this phenomenon "the specific dynamic action of food." The increase in the metabolic rate can be determined in one of two ways: (1) By direct measurement of the amount of heat actually given off by the body before and after food has been taken (direct calorimetry) or (2) by determining the amount of oxygen consumed and carbon dioxid produced under the same conditions (indirect calorimetry). When the consumption of oxygen and the production of carbon dioxid are known it is possible to calculate the actual production of heat. The investigations of Lusk have conclusively demonstrated that the results obtained by indirect calorimetry are practically identical with those obtained when the actual production of heat is determined directly.

One of the earliest and seemingly most probable explanations of the cause of the specific dynamic action of food was that it resulted from the increased activity of the gastro-intestinal tract (peristalsis, secretion, and so forth). This hypothesis at first sight appears quite likely, but has been shown to be untenable because: (1) The ingestion of bones by a dog does not appreciably elevate the basal metabolic rate; (2) vigorous peristalsis in the gastro-intestinal tract such as follows the ingestion of agar agar and cathartics, does not cause an appreciable elevation in the level of oxygen consumption or carbon dioxid production; (3) the ingestion of Liebig's extract of beef, while promoting the flow of digestive juices, does not cause elevation in metabolism, and (4) experiments in our laboratory have shown that the intravenous administration of glucose, various amino-acids, and fat may all cause marked elevation of metabolism.

Since the digestion, movement, and absorption of food from the gastro-intestinal tract is without appreciable effect on the metabolic rate, whereas the intravenous administration of

various food substances causes marked elevation, it is natural to inquire whether or not certain changes in the blood (changes in fluid content, osmotic pressure, and so forth) and increased renal activity may not elevate the metabolism. Following this line of inquiry Lusk administered large amounts of urea and sodium chlorid to dogs, and found that the presence of these agents in the blood stream and their elimination by the kidneys was without appreciable effect on the level of heat production. Unpublished experiments from our laboratory have also shown that the intravenous administration of physiologic sodium chlorid solution or even distilled water is without effect.

From this brief summary it is obvious that none of the commonly known physical changes which might be induced in the body by the ingestion of food can possibly account for the marked elevation in metabolism, and it becomes necessary to consider the various chemical reactions which may take place when food enters the cells. Experimental evidence has clearly shown that there are certain essential differences in the specific dynamic action of protein, carbohydrate, and fat, and it will, therefore, be expedient to comment on them separately.

## PROTEIN

In the gastro-intestinal tract protein is subjected to the action of pepsin and trypsin and in a large measure reduced to its constituent amino-acids which then enter the blood stream. The study of the specific dynamic action of protein can, therefore, be greatly simplified by the employment of a single amino-acid of known and relatively simple chemical composition. When the amino-acids, alanine, glycocoll or phenylalanine, are given to animals either intravenously or by mouth in suitable amounts there is a marked elevation of metabolism, and several hours may be required for it to return to the normal level; at the same time there is a definite increase in the excretion of urea nitrogen in the urine and, in well-nourished normal animals, practically all of the nitrogen which was administered as amino-acid nitrogen can be recovered in the urine as urea nitrogen. Numerous hypotheses could be advanced to explain the foregoing sequence

of events, but three only will be considered which can be fairly well analyzed in the light of experimental evidence. These three hypotheses and the experimental evidence for and against them are as follows:

1. The amino-acid may be deaminized, its nitrogen eliminated in the urine as urea, and the nitrogen-free portion burned by the cells with a resultant increase in the production of heat by the body. Lusk has shown that this hypothesis is unlikely because when he administered the amino-acids, alanine or glycocoll, to dogs that had been rendered diabetic with phlorizin, he found that practically the total amount of amino-acid was changed to glucose and urea and eliminated in the urine; in spite of the fact that practically none of the amino-acid was oxidized by the body, he found that there was marked specific dynamic action, which, therefore, could not have arisen from combustion of the amino-acid *per se*.

2. The presence of the unchanged amino-acids in the blood and tissues may act as a stimulus and raise the metabolic rate; in this case the increased urea nitrogen in the urine could be the result of increased protein destruction brought about by the elevated metabolic rate. Recent experiments in our laboratory on the dehepatized dog have shown clearly that this hypothesis is unsupported by experimental evidence. When amino-acids are injected intravenously into the dehepatized dog they are not deaminized and the total quantity injected can be recovered in the urine, blood, and tissues of the animal. If the unchanged amino-acid stimulated the body to a higher level of production of heat, a definite specific dynamic action would be noted in the dehepatized dog. A large number of these experiments have been performed, and they all show quite clearly that there is no specific dynamic action of amino-acids in the dog following removal of the liver.

3. The amino-acid may be deaminized and the nitrogen-free portion, by virtue of its specific chemical configuration, may act in a catalytic-like manner and increase the rate of cellular metabolism. Much of the evidence now available appears to support this hypothesis; in the diabetic dogs of Lusk it may be

assumed that in the change of the amino-acid to glucose and urea some intermediate substance was formed which elevated the metabolic rate, and that in the case of the dehepatized dog it may be assumed that these intermediary substances can be formed only when the liver is present. Unpublished experiments in our laboratory have also shown that the increase in the consumption of oxygen and the production of carbon dioxid which follows the injection of the amino-acids, alanine and glycocoll, is to a large extent governed by the nutritional condition of the animal, thus favoring the view that catalytic-like substances are formed from the amino-acid; the nature of the response to this stimulation would, therefore, be to some extent dependent on the supply of oxidizable substances present in the organism at that time. This general view is in accord with the theory of "amino-acid stimulation" of Lusk, who believes that the substances responsible for the increase in metabolism are possibly oxyacids or ketoacids formed by deaminization of the amino-acids.

There is one other aspect of the specific dynamic action of protein which deserves special mention. It is possible by feeding large quantities of meat to experimental animals to elevate the metabolic rate 20 to 30 per cent above the normal value. This high level of metabolism is present eighteen to twenty-four hours after the last feeding and can be maintained for several months. We have performed an interesting experiment in a thyroidectomized dog which illustrates this effect of protein. The thyroid gland was removed from a well-trained dog whose basal level of heat production was known, and the basal metabolic rate gradually fell to −30 per cent and remained at this level so long as the animal was maintained on the standard balanced diet used in the laboratory. When 300 gm. of meat was substituted for the standard diet the metabolic rate gradually rose to normal and remained at this level for several weeks; when the standard diet was again substituted for the meat the metabolic rate gradually fell to −30 per cent. During the time that the metabolism was held at the normal level by a diet high in meat the animal continued to show certain previously noted signs of hypothyroidism (shaggy dry coat, slow growth of hair, and so

forth). Thus by the use of a diet high in meat we created the paradox of an animal with hypothyroidism and a normal metabolic rate.

## CARBOHYDRATE AND FAT

Lusk has termed the specific dynamic action of carbohydrate and fat the "metabolism of plethora." When increased quantities of either of these two substances are brought to the cells, greater quantities are oxidized and the metabolism is elevated. The specific dynamic action of carbohydrate is appreciably less than that of protein, and it requires about 1 gm. of pure glucose for each kilogram of body weight (given intravenously) to bring about a constant and definite elevation of metabolism in dogs. When glucose is given to totally diabetic animals there is no elevation in the consumption of oxygen or production of carbon dioxid, thus suggesting that glucose must be oxidized in order to exert its specific dynamic action. In our experiments on dehepatized dogs we have shown that the specific dynamic action of glucose, in contradistinction to that of amino-acids, is still present after removal of the liver; in fact, it is greater than in normal animals. The greater specific dynamic action of glucose in the liverless animal is probably due to the fact that in normal animals the liver removes and stores some of the injected glucose before it can be utilized by the cells, whereas in the absence of the liver all of the glucose reaches the cells and is utilized. These experiments show that there is a fundamental difference between the specific dynamic action of glucose and amino-acids, glucose probably being directly utilized by the cells independent of hepatic function.

After an animal has been made to fast from ten to fourteen days the specific dynamic action of intravenously administered glucose is definitely lower than normal. The mechanism of this phenomenon is not entirely clear. The usual explanation given is that the glucose is stored as glycogen, and hence there is little, if any, increase in the consumption of oxygen.

Relatively little is known about the specific dynamic action of fat, but it appears that the increase in the production of heat which occurs after the ingestion of fat is largely due to increased

oxidation of fat, or is associated with its preparation for utilization or storage.

## CLINICAL STUDIES

Many attempts have been made to show that the specific dynamic action of food is abnormal in certain types of obesity and undernutrition. Most of the observations are unsatisfactory because accurate control data could not be obtained. In general, however, the results obtained seem to indicate that the specific dynamic action of food is less than normal in certain types of obesity. In certain types of undernutrition, on the other hand, it has been found that the specific dynamic action of one or all of the food substances is greater than normal, and that the nutritional status can often be improved when this particular foodstuff is limited in the diet.

The specific dynamic action of protein has been found to be within normal limits in cases of severe injury to the liver. This is in keeping with our observations of animals in which reverse Eck fistula and ligation of the portal vein had been performed. Certain of these animals have small atrophic livers, but the specific dynamic action of amino-acids is within normal limits, showing that only a small amount of hepatic tissue is necessary in order to bring about the reactions leading to the production of the specific dynamic action of amino-acids or protein.

In conclusion we wish to emphasize that a large amount of work remains to be done in clearing up certain fundamental points relative to the exact nature and cause of the specific dynamic action of the various food materials, and we cannot hope to use the determination of the specific dynamic action as a diagnostic or prognostic aid in clinical medicine until these fundamental studies have contributed a clearer understanding of the phenomena.

# DERMOID CYST OF THE PANCREAS

JAMES C. MASSON AND HAROLD D. CAYLOR

IN a general paper on cysts of the pancreas Judd, in 1921, mentioned a dermoid cyst of the tail of the pancreas. This case will be reported here, more in detail, with information regarding the patient's subsequent health.

## REPORT OF CASE

A woman aged thirty-three years, a housewife on a farm, came to the clinic because of weakness, backache, and a tumor in the left upper portion of the abdomen. The complaint apparently went back about nine years before her first visit to the clinic, when she had severe backaches, slight weakness, and anemia. Examination elsewhere at that time revealed a palpable tumor in the left hypochondrium and mild secondary anemia. The disorder was diagnosed as "spleen trouble," and the patient was put to bed for six weeks and given Fowler's solution. She apparently greatly improved during this treatment. For seven years she had good health and gave birth to two children. Two years before coming to the clinic she had an acute attack of appendicitis, and subsequently appendectomy was performed. She made a slow recovery and since that time she had had considerable backache. Soon after the operation she noticed fulness in the left half of the abdomen and consulted her physician who did not diagnose the disorder. The tumor of the left upper portion of the abdomen continued to enlarge gradually until she presented herself at the clinic.

General examination revealed a large tumor of the splenic area which moved freely with respiration and caused bulging of the ribs outward. Large vessels could be palpated over the anterior surface of the tumor. Roentgen-ray examination revealed a shadow of the left renal area, and pyelograms revealed a normal left renal pelvis with an extrarenal tumor adjacent to the pelvis. Except for mild secondary anemia, the general clinical laboratory examinations were not important. A clinical diagnosis was made of pancreatic cyst, and exploratory operation was advised.

Through a high left rectus incision a large tumor was exposed. There were many adhesions between the tumor and the adjacent structures. The cyst apparently arose in the tail of the pancreas and extended down from the left leaf of the diaphragm to the level of the left kidney. The vessels of the splenic pedicle passed directly over the anterior surface of the cyst. The tumor was approached through a hole in the great omentum between the stomach

and the transverse colon. Removal was tedious because of firm adhesions between the sac and the adjacent structures, particularly the pancreas. It was necessary to open the cyst and remove a portion of its contents in order to be able to excise it (Fig. 306). After its removal the cyst measured 15 cm. in diameter. Its contents were hair, creamy sebaceous material, and thin gray fluid. The wall of the cyst contained an incisor tooth, squamous epithelium, sebaceous glands, hair follicles, sweat glands, and connective tissue. Gallstones which were present in the gallbladder were to be removed at a subsequent operation.

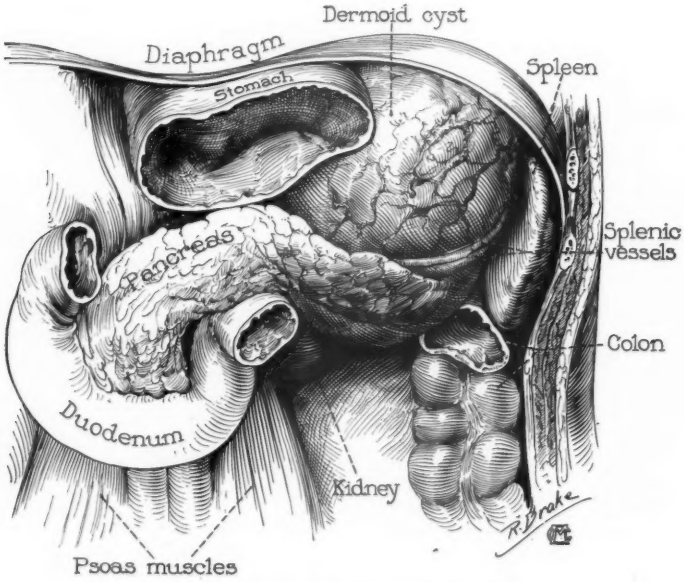


FIG. 306.—Dermoid cyst of the pancreas.

For two years following operation the patient was not well. Then gallstones were removed elsewhere, and she gained steadily. A year later she gave birth to another child. For eight years she has been in good health.

Dennis reported a dermoid cyst of the pancreas in a man aged forty years. The wall of this tumor had multiple areas of calcification and its contents were composed of hair and grumous material. The cyst could not be removed, so a marsupialization operation was performed. At the time of the report (1923) a

draining sinus still persisted, although the patient was otherwise in good health.

Dermoid cysts containing sebaceous material, hair, and other derivatives of epithelium have been found in many bizarre situations in the abdominal cavity.[2, 4] The case reported here illustrates another of the peculiar and unusual sites for these tumors.

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# PROLONGED INTRAVENOUS ADMINISTRATION OF A GUM ACACIA-CITRATED BLOOD SEQUENCE DURING SEVERE INTRACRANIAL OPERATIONS

ALFRED W. ADSON AND ARCHIBALD H. MCINDOE

CRANIAL operations are notably tedious and time consuming. The problem of maintaining an already enfeebled patient through several hours of anesthesia during which time his brain is being subjected to a radical surgical procedure is not a simple one to those on whom the responsibility rests. In any well-conducted neurosurgical clinic the surgeon, absorbed as he is in his own particular problems, should be relieved as far as possible of the worry of unforseen complications in the general condition of the patient. In most cases this responsibility is assumed by an expert anesthetist who should be as much a part of the operating team as the first assistant to the surgeon. For such operations as subtemporal or cerebellar decompression, section of the sensory root of the fifth nerve, simple exploration, and indeed for many more extensive procedures, a skilfully given anesthetic suffices, and the patient leaves the operating table after several hours with a warm, dry, pink skin, good pulse, and the loss of only a few points in blood pressure. There are certain types of operation, however, and with the introduction of the Bovey-Cushing electrosurgical unit these are becoming more numerous, in which this status is not sufficient. The resection of highly vascular meningiomas, tumors of the pituitary gland and those of the glioma group, or even of lobes of the brain, is occasionally associated with severe hemorrhage and shock. Unless one is prepared to combat such accidents instantly, fatalities are likely to occur.

It has long been the practice in The Mayo Clinic to have the patient's blood grouped and a suitable donor obtained among

friends or relatives before the operation. If this is not possible a professional donor is secured. During the operation the donor is held in constant readiness and if any unforseen hemorrhage or shock occurs transfusion is performed immediately. This of course necessitates the services of an extra assistant whose duty it is to keep close watch of the patient for signs of such emergencies. From the anesthetist, who takes the pulse and blood pressure readings every five to ten minutes, he obtains information as to the patient's condition. In most cases in which the drop in blood pressure and rise in pulse rate has been gradual, and warning of impending danger is adequate, the results have been quite satisfactory, but in certain cases in which collapse has been dramatically sudden it has failed lamentably. The reason for this lies in the fact that the five or ten minutes consumed in drawing blood from the donor and the further time occupied in searching, sometimes vainly, for a suitable vein in a patient either exsanguinated or profoundly shocked is quite sufficient to cause death before anything can be accomplished. Under such circumstances the following plan has been put into effect, so far with excellent results:

The surgeon is given a start of approximately an hour, during which time the bone flap is turned and the condition revealed. If nothing further is contemplated and the flap is closed the patient usually does not need care other than that given by the anesthetist. If, however, an extensive resection is planned, particularly in a region difficult of access, an intravenous needle entirely free of rust (gauge 16 to 18) is inserted into a suitable vein (basilic vein with the patient in the supine position, or the internal saphenous vein at the ankle with the patient prone) secured there with a small piece of adhesive tape and connected by tubing to a graduated intravenous cylinder held in a nearby stand and containing 500 c.c. of warm 6 per cent solution of gum acacia. The elevation of the cylinder is 45 to 60 cm. above the patient and is just sufficient to maintain a very slow infusion; 350 c.c. each hour is ample during this period. If the needle is free of rust, the puncture cleanly made, and the flow maintained, there is little danger of clotting in the needle

or in the vein even over long periods. Unless an emergency arises only sufficient gum acacia is used to maintain the blood pressure at a normal level and it is discontinued when all danger is past. Patients may receive 400 to 500 c.c. of gum acacia over a two-hour to a two-and-a-half-hour period; they appear to be considerably benefited thereby. Occasionally during operations in the region of the medulla or in cases in which the brain has prolapsed through the skull opening, a hypertonic solution such as 20 per cent glucose or 15 per cent sodium chlorid may be substituted in order to decrease edema in the operative field.

If, however, sudden profuse hemorrhage occurs or if the blood pressure drops with startling rapidity the container may be raised on the stand quickly and rapid infusion commenced. This is provided for by the large gauge intravenous needle. Care is taken, however, not to make the flow so rapid that the difficulties of the surgeon in controlling the bleeding are increased. If the collapse is due mostly to shock, gum acacia is used exclusively, 1,000 to 1,200 c.c. being usually necessary to turn the scale. In our hands the return of blood pressure to normal in such cases has been more easily obtained and maintained with gum acacia than with blood. When hemorrhage dominates the picture we are of the opinion that blood is indispensable. The assistant then rapidly draws the required amount from the donor and substitutes it for the gum acacia.* During this time he has the satisfaction of knowing that the condition has been under control since the outset, that valuable moments have not been lost, and that he will not contribute to the excitement of an already tense moment by anxiously searching for collapsed veins, to the distress of the surgeon and the detriment of the patient.

In a typical case of sudden collapse 750 c.c. of gum acacia may be given, to be followed by 500 c.c. of citrated blood, with the result that a systolic blood pressure as low as 60 mm. and an unobtainable diastolic pressure may be returned approximately to normal within a short time.

* Care should be taken to wash the gum acacia through with a little physiologic solution of sodium chlorid before adding the citrated blood. Gum acacia mixed with citrated blood in vitro may produce a coagulum. This does not occur in vivo.

Gum acacia was widely used during the war, but since then it has been given scant attention owing to its supposed toxicity. The toxicity apparently has been due to an inferior product so that a note on the method of preparation of a 6 per cent solution would not be out of place.

The gum acacia must be in the form of lumps (pearls), No. 1, extra quality. A solution of twofold strength is first prepared and then diluted to the required degree of concentration with freshly distilled water. Eight liters of the solution are pre-

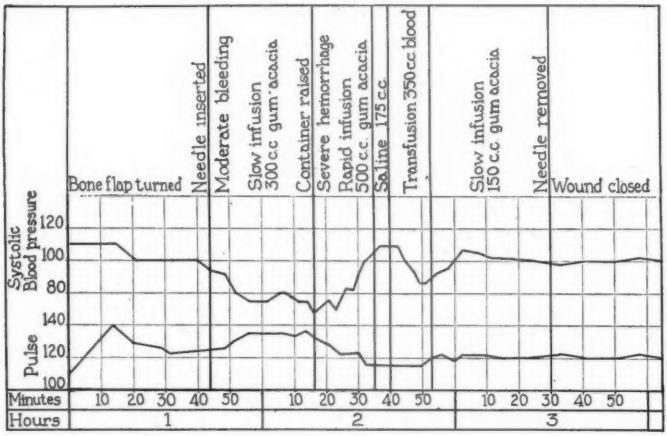


FIG. 307.—Blood pressure and pulse rate during operation.

pared in the following manner: After weighing, 480 gm. of the gum acacia and 72 gm. of sodium chlorid are placed in a 4-liter beaker, and approximately 500 c.c. of triple-distilled water is added. The gum acacia is reëxtracted by heating on a steam bath and pouring off the supernatant solution. This extraction is repeated until all the gum is dissolved. It is important to add only a small amount of water at each stage, as the gum goes into solution more readily when the lumps rub against each other freely and are not caked. The solution is then made up to a total volume of 8 liters, contained in a 12-liter pyrex flask. This turbid solution containing some dirty impurities is sterilized by

autoclave treatment. The solution is autoclaved for one-hour periods on four consecutive days. The sterilization results in the precipitation of some flocculent material which is objectionable. Attempts to get rid of this precipitation by filtration and resterilization of the filtrate are of no avail since each period of heating results in further precipitation. It is best to siphon off the clear solution above the flocculent precipitate under sterile conditions into sterile bottles. These bottles containing approximately 800 c.c. of the gum acacia solution are stoppered tightly with sterile plugs and gauze. Such a solution appears to be nontoxic and remains satisfactory for intravenous injection for several months.

The advantages of the prolonged gum acacia-citrated blood sequence are:

1. Gum acacia properly prepared is nontoxic, can be kept for some time, and is always at hand. It is quickly administered and can be used in larger amounts than blood if shock is prominent. In many cases it is alone sufficient.

2. It is inexpensive and the patient may often be spared the additional cost of a donor.

3. When hemorrhage becomes prominent the gum satisfactorily bridges the gap from the time the emergency arises until the blood can be drawn and given. Under such circumstances blood should always be substituted.

4. The early introduction of the needle while the veins are easily punctured avoids the trying search for collapsed veins during the emergency itself. The preliminary slow infusion aids materially in keeping the patient at a constant level, and by reason of the small amount actually used does not appear to increase bleeding in the operative field.

5. The most important consideration is that the patient's condition is kept well under control at all times, since the rate of flow can be altered to suit varying needs. Much of the danger of sudden collapse from hemorrhage and shock during severe intracranial operations may thus be eliminated.

# NEOPLASM CONFINED TO A DIVERTICULUM OF THE BLADDER: REPORT OF A CASE

VERNE C. HUNT

DIVERTICULA of the urinary bladder are frequently observed secondary to the obstruction of the neck of the bladder. They occur almost entirely in the male and in most instances at the prostatic age. They appear usually as herniations, between the muscle fibers of the wall of the bladder, when difficulty of urination, by virtue of a degree of urinary obstruction, requires greater expulsive power in the effort to empty the bladder. Although true congenital diverticula have been reported, it is reasonable to assume that most diverticula are acquired. In my experience from 5 to 7 per cent. of patients with surgical prostatic obstruction have also a single diverticulum or multiple diverticula of the bladder large enough to require surgical extirpation. These diverticula have a capacity of from about 30 c.c. to that of the bladder itself.

The diagnosis of diverticula of the urinary bladder is no longer difficult and surgical methods of extirpation have been adapted to diverticula in all situations.

Stones associated with retention of urine have often been observed in cases of diverticula, and stones confined entirely to diverticula have been observed; whether or not they have been primary in diverticula or have developed higher in the urinary tract or bladder, and have subsequently become confined in diverticula because of the small orifice between it and the bladder is difficult to determine.

Frequently diverticula have been found associated with primary malignant disease of the bladder. The interior of the diverticulum has been involved secondarily by direct extension

from the primary lesion through the orifice of communication with the diverticulum in cases in which the primary lesion of the bladder had been in close proximity to the diverticulum. If the malignant lesion involves the wall of the bladder adjacent to the orifice of the diverticulum and the interior of the diverticulum as well, it is extremely difficult to determine whether the lesion has been primary in the bladder or in the diverticulum. A number of such cases has been observed in the clinic. Judd and Scholl reported the association of carcinoma of the bladder and diverticulum in ten cases, in six of which it was definitely determined that the malignant lesion was primary in the bladder and that the diverticulum was involved secondarily. There was some question regarding the primary source of the lesion in three of the other four cases.

Primary malignant disease in a diverticulum is extremely rare, but it does occur, and may definitely be considered as primary within the diverticulum when it is confined to the diverticulum. The report of such a case follows:

A man aged fifty-five years came to The Mayo Clinic December 20, 1928. A diagnosis of a tumor of the bladder had been made. Three months previously he had noticed gross hematuria. He had consulted a urologist, who on cystoscopic examination found what appeared to be a small tumor of the lateral wall of the bladder. Aside from the intermittent hematuria there were no symptoms referable to the bladder or urinary tract.

At the time of examination the urine contained a great deal of blood and many pus cells. The hemoglobin was 63 per cent. Erythrocytes numbered 4,190,000. The Wassermann reaction of the blood was negative. The phenolsulphonephthalein return was 55 per cent. in the combined intravenous test, and the blood urea was 23 mg. for each 100 c.c. Roentgenograms of the kidneys, ureters, and bladder were negative. Cystoscopic examination disclosed a single pedunculated tumor about 3 cm. in diameter in the right wall of the bladder about 2 cm. above the right ureteral orifice. A specimen was removed from the tumor and was examined microscopically. It proved to be an epithelioma, graded 2, according to Broders' index (Fig. 308). The tumor was treated by electrocoagulation on two occasions. A cystogram then showed a diverticulum (Fig. 309) of the right wall of the bladder with its orifice corresponding approximately to the site of the tumor in the bladder. The cystoscopic examination was repeated and the orifice of the diverticulum was found to be the site of the tumor which had been projecting from the diverticulum.

Exploration and excision of the diverticulum was done January 22, 1929.

The diverticulum was about 4 cm. in diameter, situated as noted on cystoscopic examination, and was removed in resection of the bladder. Normal mucous membrane about the orifice of the diverticulum was removed. The tumor involved the whole interior of the diverticulum and was confined

FIG. 308.—Papillary epithelioma, graded 2.

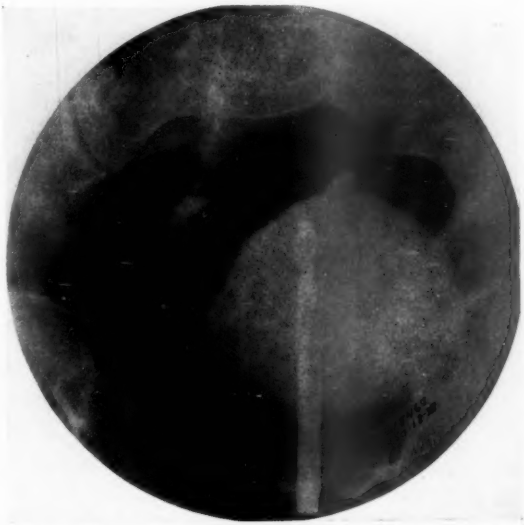

FIG. 309.—Cystogram showing only outer rim of diverticulum of the right lateral wall. Filling defect in diverticulum apparently is due to the tumor within the diverticulum.

entirely to the diverticulum (Fig. 310). The portion of the tumor which had previously been treated by transurethral coagulation was simply a proection of the tumor from the diverticulum and did not involve the mucosa of the bladder. The patient's convalescence was entirely satisfactory and he was dismissed on the eighteenth day. The wound was healed.

FIG. 310.—Interior of diverticulum; extensive involvement of the walls of diverticulum by papillary epithelioma is shown.

I have not been able to find in the English literature more than twelve authentic cases of malignant disease confined to diverticula of the bladder. It is probable, however, that the incidence is much higher, but the cases have not been reported. Hinman, Lower, and others have reported large series of cases of diverticula of the bladder without mention of malignant disease primary in and confined to diverticula. Caulk recently reported three cases out of a series of 100 diverticula of the bladder in which tumors existed within the diverticulum. In two of these cases the tumor was definitely primary in the diverticulum, whereas in the third case it had extended into the bladder. Last year I reported in detail four cases of primary epithelioma

in diverticula observed in The Mayo Clinic. Targett, Young, Thomas, Harris, Buerger, and Deming have reported similar cases.

The case reported here is the second in The Mayo Clinic in which the preoperative diagnosis of a malignant growth within a diverticulum was established. In three of the four cases reported previously the malignant lesion was found only at operation or after extirpation of the diverticulum. Only when there is projection of the tumor from the orifice of the diverticulum into the bladder, as in one of the cases reported previously and in the case reported here, may the diagnosis be made on cystoscopic examination. A filling defect in the diverticulum as depicted in the cystogram may suggest the diagnosis of tumor within the diverticulum, as in one of the cases reported previously.

Hematuria which is unexplained in the presence of diverticula of the bladder should suggest the possibility of a neoplasm within the diverticulum.

Extravesical excision of the diverticulum after adequate exposure facilitates the complete removal of such a diverticulum with the least trauma or the least dissemination of malignant cells. It would seem that in the absence of extradiverticular invasion to the bladder or surrounding structures that complete extravesical extirpation of the diverticulum should afford excellent prospects of cure. This is particularly true for the tumors of low-grade malignancy. In the five cases I have reported the malignancy of the tumor was graded 2 in three cases and 4 in two.

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# METHOD OF METASTASIS OF PAPILLARY EPITHELIOMA OF THE RENAL PELVIS

CONSIDERABLE difference of opinion exists among pathologists regarding the classification of malignant tumors of the kidney. Foulds, Eisendrath, and others have presented classifications, but as yet none has been uniformly adopted that will enable intelligent discussion of malignant tumors of the kidney. The pathologists of The Mayo Clinic have considered all malignant tumors under four headings: Hypernephroma, carcinoma, epithelioma, and sarcoma. Malignant tumors of the kidney are usually highly malignant, and are often well advanced before symptoms are produced or their presence recognized. Hypernephroma, carcinoma, and sarcoma usually progress by direct extension, invading adjacent renal tissue and extrarenal structures, and often extending directly into the renal vein, favoring early remote metastasis. The same is true of the sessile type of primary epithelioma of the renal pelvis. The papillary type of epithelioma of the renal pelvis has proved to be the least malignant renal neoplasm so far as its cellular characteristics and methods of extension and metastasis are concerned. True papillary epithelioma usually is a superficial lesion of the mucous membrane of the pelvis of the kidney and tends to remain confined to mucous membrane without involvement of the parenchyma of the kidney. If extension occurs it is along the mucous membrane of the pelvis to the calices and down the ureter to the mucous membrane of the bladder; that is, the lesion is not of an infiltrating type of lesion.

Some time ago in a review of the cases of primary papillary epithelioma of the renal pelvis observed at the clinic it was found that metastasis to the bladder occurred in two-thirds of the cases. Such metastasis was present at the initial cystoscopic examination or developed subsequent to nephrectomy or neph-

rectomy and partial ureterectomy. Involvement of the ureter has frequently been noted and usually partial ureterectomy has been performed at the time of nephrectomy when the true nature of the lesion was recognized at the time of operation. Experience has shown that it is most important to ascertain the true pathologic nature of the lesion at the time of operation if it has not been definitely ascertained before, for simple nephrectomy or nephrectomy and partial ureterectomy does not suffice as for other malignant lesions of the kidney. The importance of the intramural portion of the ureter in the complete elimination of the pathway of extension of papillary epithelioma has not been fully appreciated. In several cases in which the entire ureter had been removed to the bladder, recurrence has developed in the intramural portion of the ureter and in turn in that portion of the bladder adjacent to the ureteral orifice. Complete ureterectomy is accomplished only when the intramural portion of the ureter is included in the operation. Although recurrence has as yet not been observed in any case in which complete ureterectomy, including the intramural portion of the ureter, has been carried out, involvement of the mucous membrane about the ureteral orifice has been observed in several cases at the initial cystoscopic examination, necessitating segmental resection of the bladder simultaneous with nephro-ureterectomy. It was such extensive invasion of the disease which led to the adoption of segmental resection of the bladder including the entire thickness of the bladder for at least a centimeter beyond the area of involvement, or a centimeter beyond the ureteral orifice in the absence of involvement, simultaneous with nephro-ureterectomy in all cases in which the diagnosis of primary papillary epithelioma of the renal pelvis has been established.

With invasion of the ureter, obstruction frequently occurs with resultant hydronephrosis. Two cases are here presented which not only illustrate the method of extension of the disease but also the development of hydronephrosis incident to the ureteral obstruction.

**Case I.**—A man aged fifty-two years came to the clinic November 26, 1926 on account of pain in the upper right quadrant of the abdomen, which

had been present to some extent about a year, but had been constant and severe for a month. There was some urinary frequency and occasionally hematuria had been noted. The systolic blood pressure was 106 and the diastolic 72. The general examination was negative with the exception of a huge cystic mass occupying the entire upper right quadrant of the abdomen and extending back into the area of the right kidney, which was considered of renal origin. In the urine there was a great deal of blood and very few pus cells. The combined phenolsulphonephthalein test showed a return of 35 per cent of the dye in two hours. The blood urea was 32 mg. Roentgen-ray examination of the kidneys was negative for shadows. Cystoscopic examination revealed hemorrhagic urine from the right ureteral orifice. The

FIG. 311.—Inner surface of pelvis and calices showing multiple lesions of papillary epithelioma of the pelvis.

pyelogram showed huge sacculation of the pelvis and calices. A differential functional test did not show function of the right kidney. A diagnosis of a functionless hydronephrotic kidney was made with the possibility of a coincident pathologic process to account for the hematuria.

At operation, December 9, 1926, a huge right hydronephrotic kidney, 25 by 15 by 15 cm., was removed. The upper half of the ureter was removed at the same time. There was practically complete destruction of all renal tissue as the result of extensive papillary epithelioma of the renal pelvis obstructing the ureter. The lesions were multiple, the largest 5 cm. in diameter (Fig. 311). According to Broders' index this was epithelioma, graded 4

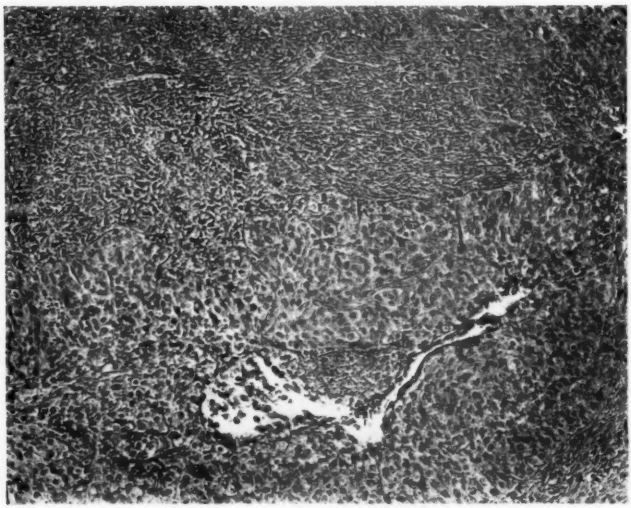

FIG. 312.—Papillary epithelioma of the renal pelvis (Case I).

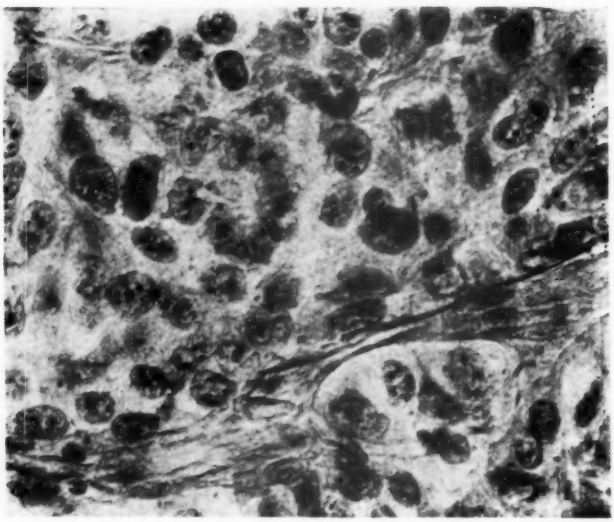

FIG. 313.—Higher magnification of Fig. 312.

(Figs. 312, 313). Convalescence was uneventful. The patient was examined six months later and was found to be perfectly well without evidence of recurrence. Reëxamination in May, 1928 was negative. The patient returned in September, complaining of pain in the right lower quadrant and recent hematuria. An indefinite mass could be felt at this time in the lower right quadrant along the course of the ureter. The urine contained a few erythrocytes, and cystoscopic examination showed what appeared like granulation tissue about the right ureteral orifice.

At operation, October 4, 1928, the remainder of the ureter was about 1 cm. in diameter, and very hard as the result of being filled with recurrent papillary epithelioma. The remainder or lower half of the ureter was removed with a large segment of the bladder well around the secondary involvement of the bladder adjacent to the ureteral orifice. The sectional ureter showed solid involvement to well beyond the ureteral orifice of the same degree malignant papillary epithelioma as was found in the kidney. Convalescence was uneventful.

The original nephrectomy was performed in this case previous to the review of cases of papillary epithelioma and previous to the time that it was recognized that more radical operation than simple nephrectomy and partial ureterectomy was necessary for the papillary type of epithelioma. The events subsequent to the original nephrectomy in this case present additional evidence to that presented two years ago, that metastasis in the papillary type of epithelioma of the renal pelvis occurs directly along mucous membranes to the calices and along the ureter to the bladder in all cases, given sufficient time. I recommended at that time, in view of the high percentage of cases in which involvement of the lower part of the ureter and bladder was present at the initial examination, or occurred subsequent to simple nephrectomy or nephrectomy and partial ureterectomy, that once the diagnosis of primary papillary epithelioma of the renal pelvis or ureter was made more radical operation was necessary than for the other types of renal malignancy.

**Case II.**—A man aged forty-six years came to the clinic on account of intermittent hematuria of about eight months' duration. During the last four months the patient had noted gradual enlargement of the abdomen. On examination there was great enlargement of the abdomen, most marked on the right side. This enlargement seemed to be cystic. The specific gravity of the urine was 1.022 and the urine contained a large amount of albumin and many erythrocytes and pus cells. The hemoglobin was 65 per cent. The Wassermann reaction of the blood was negative. The blood urea was 32

mg. for each 100 c.c. Roentgenogram of the kidneys, ureters, and bladder was negative except for phleboliths on both sides. Cystoscopic examination

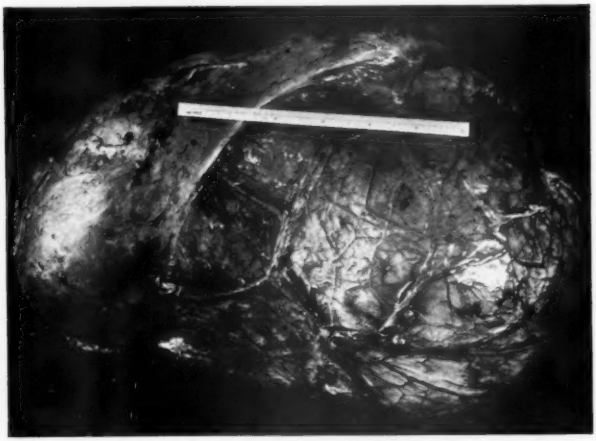

FIG. 314.—Large hydronephrotic kidney (Case II).

FIG. 315.—Interior of hydronephrotic kidney showing the multiple lesions of papillary epithelioma.

revealed a single circumscribed bit of tumor tissue protruding from and surrounding the right ureteral meatus, a specimen of which was removed for microscopic examination and proved to be epithelioma, graded 3. Urine

was not seen escaping from the right ureteral orifice and the right ureter was not catheterized. The function of the left kidney was normal.

The diagnosis was papillary epithelioma of the right renal pelvis, with implants in the ureter and bladder, and hydronephrosis. At operation there was a large hydronephrotic kidney which occupied the entire right side of the abdomen, and extended well across the median line. Transperitoneal nephrectomy was performed, with removal of the upper two thirds of the ureter with the hydronephrotic sac without rupturing it. Convalescence was uneventful, and after about two weeks the remainder of the ureter and a segment of the bladder about the ureteral orifice were excised. There were two papillary epitheliomas of the ureter, one just proximal to the intramural

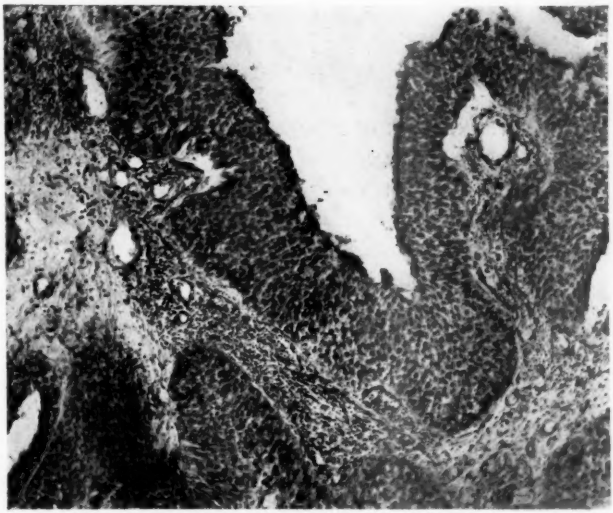

FIG. 316.—Papillary epithelioma of renal pelvis (Case II).

portion of the ureter, and the other, which was the larger, in the intramural portion of the ureter involving the meatus. The hydronephrotic kidney weighed 600 gm. (12.5 pounds) and measured 31 by 26 by 12 cm. (Fig. 314). The renal tissue was thinned out to a mere shell and the major portion of the mass consisted of renal pelvis, which was dilated to form a huge sac. On the inner surface of the sac (Fig. 315) as well as within the ureter were multiple areas of grayish-white fungoid tumor tissue, confined in all areas to the mucous membrane. Microscopically these tumors were identical with the specimen removed through the cystoscope (Fig. 316). The degree of differentiation was slight and mitotic figures were numerous. The tumor was graded 3 according to Broders' classification of malignancy. Recent investigation one year after operation did not disclose evidence of recurrence.

## COMMENT

Hydronephrosis was marked in these two cases due to obstruction of the ureter by tumor. As a result of intermittent occlusion hydronephrosis of a variable degree is present in nearly all cases, and with the development of hydronephrosis a mass is usually palpable. It may be after careful urologic investigation that a diagnosis of hydronephrosis only can be made; however, in any case in which gross or microscopic hematuria occurs in hydronephrosis the possibility of a tumor of pelvic origin should be considered. In about a third of the cases observed at the clinic cystoscopic examination disclosed a clue to the diagnosis of papillary epithelioma in that a tuft of tissue was seen projecting from the ureteral orifice or there was definite extension of the lesion to the area of the bladder immediately adjacent to the ureteral orifice. Likewise the diagnosis in several cases was suggested by the filling defect in the pelvis as shown in the pyelogram. In about half of the cases the preoperative diagnosis was either hydronephrosis or renal neoplasm and the diagnosis of papillary epithelioma was made only at operation.

It has been recommended in the past that in all cases of primary papillary epithelioma of the renal pelvis or ureter that the ureter should be removed down to the wall of the bladder at the time of nephrectomy, or at a second-stage operation soon afterward. However, the revelation of the high incidence of metastasis to that portion of the bladder immediately surrounding the ureteral orifice, or immediately adjacent to it, emphasizes the necessity of segmental resection of that portion of the bladder to include the intramural portion of the ureter and the adjacent area simultaneously with nephro-ureterectomy to insure the best prognosis. The results seem to show that the interval between nephrectomy and subsequent ureterectomy, as a second-stage operation, is an important factor in the prognosis, and is readily obviated by the one-stage complete operation of nephro-ureterectomy with segmental resection of the bladder.

If the diagnosis of papillary epithelioma of the renal pelvis has been accurately established by the presence of metastasis to the bladder it is desirable to proceed with exposure of the lower

portion of the ureter and resection of the bladder before the kidney is removed. This facilitates removal of the entire specimen intact. Through a low median incision, extending from the pubis to the umbilicus, extraperitoneal access to the lower two-thirds of the ureter and bladder is readily afforded. The ureter is readily freed down to the ureterovesical juncture, and the base of the bladder is elevated to allow excision of the intramural portion of the ureter and an area of bladder wall immediately adjacent to it. In the event of metastasis to the bladder this facilitates such wide segmental resection as to include at least 1 cm. of normal bladder wall around the growth. The resected segment of the bladder and lower portion of the ureter are wrapped in gauze and tucked high in the extraperitoneal space toward the kidney. After the bladder is reconstructed and the anterior incision is closed, the patient is turned on the side, and through the posterolateral incision, which gives access to the upper third of the ureter, the kidney, ureter, and resected segment of bladder are removed intact. There is no particular object in removing the specimen intact in the absence of involvement of the ureter or bladder; however, division of an affected ureter favors transplantation to the perirenal and periureteric tissues. Whether the ureter is divided or not is probably of minor importance.

I would emphasize that as far as malignant tumors of the kidney are concerned, papillary epithelioma of the renal pelvis is the least malignant. It tends to progress by extension along the mucous membrane of the pelvis, ureter, and bladder. Even though the grade of malignancy remains the same as that of the primary lesion, the prognosis is materially altered when extension to the bladder has occurred. In order to forestall such metastasis segmental resection of the bladder should be performed simultaneously with complete nephro-ureterectomy.

# MEGACOLON SECONDARY TO CARCINOMA OF THE SIGMOID: REPORT OF THREE CASES*

FRED W. RANKIN

SINCE Finney, collaborating with Fisher, published a most exhaustive and brilliant article on megacolon in 1908, only one contribution has been made to the etiology, symptoms, or treatment, medical or surgical, of this deplorable condition. The single suggestion has been made that bilateral ramisection of the lumbar sympathetic nerves offers surgical relief. This operation is based on an unproved hypothesis and has been applied in an extremely small number of cases, in which postoperative life has been extremely short. Until further proof is offered that this is a curative procedure in true Hirschsprung's disease, it seems wise to reserve judgment on its applicability to the usual cases which appear for treatment.

The uncertainty concerning the etiology of megacolon is so great that more than twenty-two theories have been advanced as to its production, and it is because of this division of opinion as regards its production that methods of treatment have been so inadequate. Likewise, due to lack of adequate segregation of the disease into proper classes, additional confusion has resulted; many cases of adult megacolon have been recorded as of the infantile type and, consequently, the same measures of treatment have been applied in them as if they had been cases of true Hirschsprung's disease. Unquestionably, the acquired type of megacolon, although pathologically identical with its congenital relative, differs etiologically from practically every standpoint, from the ailment described by Hirschsprung in 1886. His description of the pathologic changes and symptoms as "a condition of congenital high-grade dilatation of the colon with

* Read before the Western Surgical Association, Chicago, Illinois, December 14–15, 1928.

thickening of all its tunics, especially the tunic muscularis, and retention of large quantities of fecal matter" remains a satisfactory definition of the disease as we see it today. There has been failure to distinguish, then, between pseudomegacolon, a classification in which Finney, Ladd, and others concur with Hirschsprung, which develops in adult life, and the true Hirschsprung's disease, which is probably only found in childhood. This confusion has but added to the chaos which already surrounds the description and treatment of this ailment. The etiology of megacolon has evoked so many hypotheses that in going over the literature carefully I have thought they might be reduced to a résumé under five headings, with numerous subdivisions, as follows:

1. Congenital defects (Hirschsprung, Mya).
2. Obstructive processes:
   - Elongation of mesentery and consequent torsion of a segment of bowel (Barth).
   - Elongation of the entire colon and multiplication of the number of its loops (Marfan).
3. Anatomic conditions:
   - Valve formation (Perthes, Roser).
   - Aplasia of musculature of colon immediately above rectum (Concetti).
   - Mechanical obstruction (Treves).
   - Congenital stricture of rectum (David).
   - General systemic condition.
   - Diastasis of recti abdominales (Levi).
   - Adhesions to surrounding structures (Murray).
   - Wasting diseases (Griffith).
4. Nervous mechanisms:
   - Segmental neuromuscular defect (Hawkins, Lennander, Formad).
   - Systemic system (Bing).
   - Spastic contracture of sphincter ani (Fenwick).
   - Spastic contracture of intestinal segment (Gee and Hutchins).
5. Infective processes (Walker and Griffith).

Most writers agree that congenital developmental defects or primary obstructive conditions produce giantism of the colon. The obstructive condition may be primary or secondary. Either is accompanied by the two characteristics, hypertrophy and

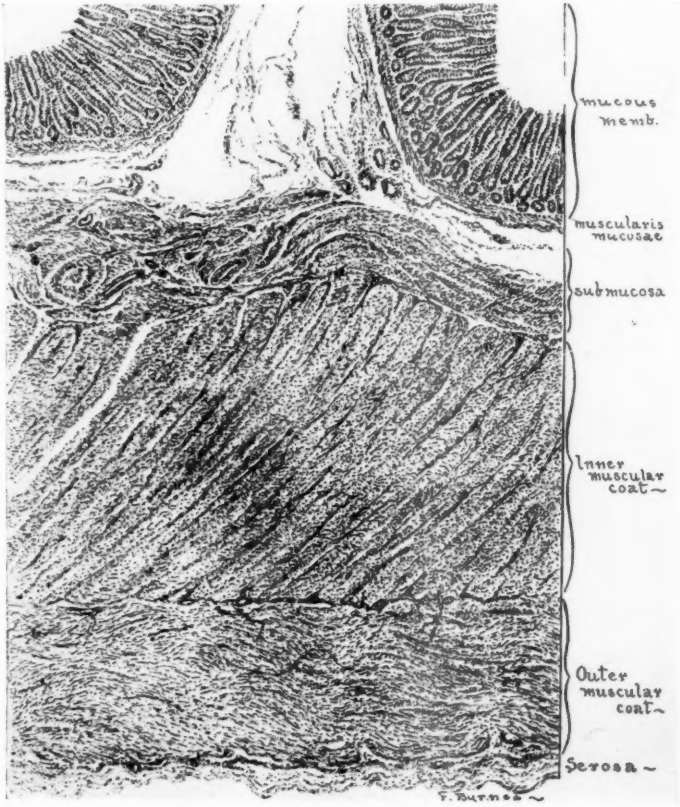


FIG. 317.—Section through wall of hypertrophied colon.

dilatation, which are found reported in all cases; but the exact relationship between these conditions and the causes of their occurrence is not clear. Any mechanical obstruction of the large bowel, like obstruction in other organs, for instance, in the

ureter, is followed by hypertrophy above the obstruction, as a result of peristaltic action which, working against difficulty, endeavors to overcome stenosis. The possibility that hypertrophy in megacolon may be due to congenital defect, and that the dilatation may be due to excessive muscular action, is an intriguing theory. Yet, since both may be present in the fetal intestinal canal prior to birth, numerous anatomic conditions may offer an explanation of the underlying obstructive factors.

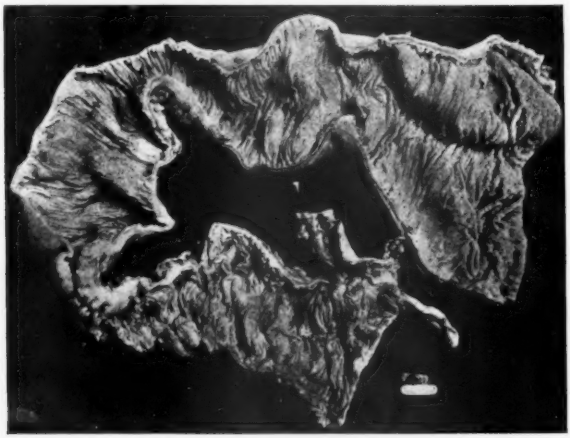

FIG. 318.—Typical appearance of interior of a gross specimen of Hirschsprung's giant colon.

The exhaustive studies of Barrington-Ward on megacolon prove conclusively that congenital defects occur most commonly at the juncture of the proctodeum and hind-gut, and next at the juncture of the foregut and midgut. These congenital defects result in megacolon when they occur at the former site, and in such parallel conditions as hypertrophy of the pylorus when they occur at the latter site.

The three cases which I am reporting, although pathologically agreeing in all particulars with Hirschsprung's description of congenital megacolon, were all produced by obstruction of similar kind due to an encircling carcinoma of the sigmoid.

The mechanism of this obstruction is easily explained and the method, as well as its results, coincides satisfactorily with the theory that obstructive processes, with peristaltic action, result

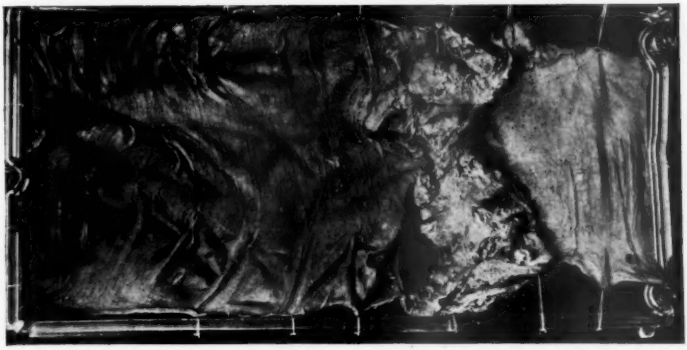

FIG. 319.—Gross specimen showing constricting carcinoma and typical appearance of bowel above this obstruction.

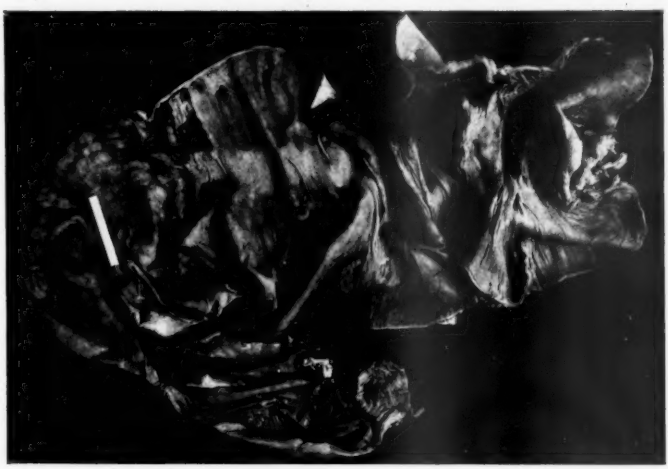

FIG. 320.—Gross appearance of resected bowel after it has been emptied of the huge tumefaction. Specimen weighed 4800 gm. The upper half was 9 cm. in diameter and the lower half was 12 cm. in diameter. The carcinoma was small, annular, and without demonstrable metastasis despite its long history.

in hypertrophy of all the tunics of the large bowel. These cases presented formidable complications in addition to the malignant disease which is the underlying etiologic factor. In two of them acute obstruction was present which necessitated an emergency measure for its relief. In the third case chronic obstruction had produced huge megacolon in which the retained fecal content had become a tumor irremovable by trocar and necessitating resection of three-fourths of the colon, a most hazardous and dangerous procedure under any obstructive conditions.

## REPORT OF CASES

**Case I.**—A woman aged sixty-five years came to the clinic October 29, 1924. Her chief complaint was of constipation. She never had been constipated until June, 1924, when laxatives were necessary to effect bowel movement. In June two days elapsed without a bowel movement; she became nauseated, but she did not vomit and fever was not present at any time. Enemas afforded much relief. She continued to take laxatives after this. In September she had a similar attack of constipation and was relieved by an enema. She consulted a physician who thought she had obstruction at the splenic flexure. Since that time enemas, in addition to laxatives, were necessary to effect bowel movements. She felt very well except when badly constipated, at which times she had much gas, but acute pain was not present. There had been some loss of weight since September.

On deep palpation of the abdomen something suggesting an immovable mass was felt to the right and a little above the umbilicus. Urinalysis was negative. The hemoglobin was 73 per cent; the erythrocytes numbered 4,430,000, and the leukocytes 5,800 in each cubic millimeter. Roentgen-ray examination of the colon showed a large dilated colon with a marked kink in the ascending colon; the cecum was to the left of the median line between the sigmoid and transverse colon.

The patient returned to the clinic in March, 1925. After leaving here early in November she did well and was able to do her work. With laxatives she had from two to six bowel movements daily and sometimes several at night. She was on a normal diet at first, but later she was given a diet largely of liquids and soft food, and the stools became less and less numerous. About three or four weeks previous to this visit she noticed increasing abdominal gas which she was unable to expel. Ten days previous to this visit she noticed a trace of blood in the stools, with some mucus. The abdomen increased in size and the patient felt that the enlargement embarrassed breathing. She could not take enemas, as the water would not enter the bowel. She called a physician, who advised her to return to Rochester. She did not vomit, but was nauseated and complained much of dry mouth.

Examination revealed a dyspneic, poorly nourished woman with the appearance of being dehydrated and with rapid pulse. The abdomen was

markedly distended and was tympanitic to the flanks, causing some tenderness at the costal margins. She entered the hospital on the day of arrival and a diagnosis was made of carcinoma of the sigmoid with obstruction and megacolon.

The patient was operated on March 24 for acute intestinal obstruction. The report of the surgeon was as follows:

"The patient apparently has Hirschsprung's disease and has had a slowly developing obstruction which became acute several days ago. Exploration was through a low median line incision. The entire colon appeared to be distended four to five times normal size and was filled with hard, fecal material. A catheter was introduced into a piece of bowel which appeared to be colon, but it was impossible to say just what portion of the colon this was, as practically no exploring was done. The catheter was sutured into what was most likely either the cecum or the transverse colon. Slight soiling occurred. Before the patient was removed from the operating table about 1,500 c.c. of liquid bowel material drained out of the tube. The patient had extreme distention. If she survives the present operation she is to have some operative procedure for Hirschsprung's disease later."

The patient died March 30, 1925. The clinician's report of death was as follows:

"The patient entered the hospital on March 24, 1925. She was operated on for intestinal obstruction on this date and cecostomy was performed. Her condition was fair the following three days with diminishing abdominal distention and discomfort. On the fourth day confusion, with sluggishness and increased weakness, appeared. Blood urea, March 28, was 80 mg. in each 100 c.c. There were red blood cells, casts, and albumin in the urine; the output for twenty-four hours was 700 c.c. On the fifth day the temperature and pulse became elevated; urine was voided involuntarily, and the patient remained irrational until the time of death."

*Comment.*—An epitome of this case shows that this woman, aged sixty-five years, had had obstruction beginning six months previously with two subacute exacerbations which were relieved by enemas and purgatives of physiologic solution of sodium chlorid. Three weeks previous to admission to the clinic subacute obstruction developed which was not relieved by the usual methods; but the gaseous distention, blood in the stools, and increasing size of the abdomen persisted and advanced until there was considerable embarrassment in breathing. On the day of admission her condition was that of acute obstruction, which precluded any routine examinations and for which an emergency drainage operation, consisting of cecostomy, was done. She died six days later, although the obstructive symp-

toms were relieved. Contamination, however, could not be avoided.

**Case II.**—A man aged fifty years came to the clinic October 5, 1925. His chief complaint was of pain in the abdomen which had been present about three months. He always had been markedly constipated, but in July this condition had become much more marked. Obstruction was present at that time, and two enemas were necessary before relief by small defecation and much flatus was obtained. Emesis also was present. In August he had two similar attacks of obstruction which were associated with nausea and emesis. There had been a loss of 50 pounds in weight in three months, with marked weakness. Pain in the left lower quadrant of the abdomen was a frequent symptom and he gave a history of burning and discomfort coming on about two hours after meals. This had been present since the preceding March. For the two weeks immediately preceding admission to the clinic dysuria and frequency with nocturia, graded 1, had been present.

On examination the abdomen was found to be distended, but definite masses were not found. Urinalysis disclosed albumin, graded 1; hyaline casts, graded 3; granular casts, graded 2, and pus, graded 1, with five cells to the microscopic field. The blood urea was 30 mg. in each 100 c.c. The hemoglobin was 60 per cent; the erythrocytes numbered 3,980,000, and the leukocytes numbered 7,400 in each cubic millimeter. The patient weighed 170 pounds.

A diagnosis of carcinoma of the colon was made and October 9 operation was performed. The surgeon's report was as follows:

"The patient had marked obstruction of the colon and small intestine. The abdominal cavity contained a small amount of free fluid. A malignant growth was found in the region of the rectosigmoid which was producing the obstruction. The colon was cut across between double clamps at a point near the middle of the transverse colon, and each of the ends was brought out of the abdominal incision. At a later date the malignant condition is to be explored through a low median line incision, and if the growth can be removed satisfactorily the colostomy which was made today may be closed as a Mikulicz operation. Operation was done with much risk, since almost complete obstruction had existed for several days."

Two days following operation the temperature and pulse were very high, but the patient did not complain of discomfort and did not cough. The abdomen was distended, but there was only moderate rigidity, with tenderness in the right lower quadrant. There was some fecal drainage through the colostomy opening. There were many moist râles in the upper portion of the right lung and the heart beat was rapid. The following day the patient began to show signs of a comatose state and he died at 7.35 o'clock that evening.

Postmortem examination was made and the report of what was found is as follows:

"Colostomy (emergency) for obstructing, annular, fungating carcinoma of the rectosigmoid; distention, with hypertrophy, of the proximal colon;

perforation and localized adhesions just distal to the carcinomatous mass; generalized peritonitis and bilateral bronchopneumonia; distention and ulceration of the distal two-thirds of the appendix (2 cm. in diameter) with adhesions to the brim of the pelvis, and ulceration of the terminal ileum."

*Comment.*—This case was that of a man aged fifty years and had many interesting features. Whereas subacute obstruction was present at the time of operation, the case was not as bad a risk as Case I. The patient had lost 50 pounds in weight in the short period of three months and had had two subacute attacks of obstructive symptoms which were relieved by enemas. On coming to the clinic he had mild obstructive symptoms which were not sufficiently urgent to warrant an emergency operation. He came to operation with a distended colon, a small amount of free fluid in the abdomen, and about 75 per cent stenosis of the lumen of the bowel. Colostomy for drainage purposes was done, but the outcome was unsatisfactory and the patient died two days later.

**Case III.**—A man aged sixty-four years came to the clinic October 10, 1927. His chief complaint was of carcinoma of the rectum which had been present for two years. He gave a history of having had constipation sixteen years previously. Fourteen years previously he had had symptoms of disease of the gallbladder with jaundice for five weeks and pain in the left flank. Constipation had followed this attack, but later it had cleared up until four years previous to his coming to the clinic, when constipation again had become marked. This had increased in severity and he suffered from gas pains. Two years later he had had obstruction and had consulted a physician, who had done colostomy on the right side. At that time he had been told that he had a carcinoma and that he could expect to live for from six months to one and a half years. Since that time he had lost only 10 pounds in weight and had felt well. He had had only a mucous discharge from the rectum, no feces or gas.

On general examination it was found that the abdomen was tense and that gas escaped through the stoma of the colostomy. There was a sense of a nodular mass in the sigmoid, but deep palpation was impossible at the time. Rectal examination was negative and the mass could not be felt. Urinalysis was negative. The hemoglobin was 70 per cent; the erythrocytes numbered 4,540,000, and the leukocytes numbered 11,600 in each cubic millimeter. Examination of the chest did not disclose anything abnormal.

A diagnosis of carcinoma of the sigmoid was made and the patient was operated on October 17, 1927. The surgeon's report was as follows:

"There was carcinoma of the sigmoid (completely obstructing). Hemicolectomy was done, leaving clamps on both ends of the bowel. A lymph-node

was excised for diagnosis. Completely obstructing carcinoma of the sigmoid, with huge megacolon, was found. The patient had had cecostomy for carcinoma two years before and came here with subacute obstruction. Enemas did not relieve him either of gas or of fecal matter through either the rectum or the cecostomy opening. I explored through a low median-line incision and could not find metastasis to the liver. I excised a regional lymph-node which was reported to be inflammatory in nature. There was a definite, almost completely obstructing carcinoma at the juncture of the middle and lower thirds of the sigmoid flexure. The colon, up to the splenic flexure, was dilated so that its diameter was about 20 cm. It was filled with fecal material. I tried to put a trocar into the colon to evacuate its contents with the idea of putting in a Paul tube, but was unable to get anything out. The transverse colon was dilated, graded 2+. Exploration showed that there was a second obstruction, of an inflammatory type, at the splenic flexure which was preventing the cecostomy from functioning. Because of this fact I did a rapid hemicolectomy beginning in the middle of the transverse colon and going down into the lower third of the sigmoid. I left clamps on both ends of the bowel and closed the wound around them. I could not cover the lower surfaces with peritoneum because it seemed best to hurry the operation as much as possible on account of the patient's poor condition. There was one break of technic when clamps were put on the transverse colon, a small opening being made in the loop. The chance of immediate mortality is approximately 25 per cent."

The pathologist's report was as follows:

"Annular adenocarcinoma (3 cm.) with no lymphatic involvement found."

The patient left the hospital November 19 and went directly home. The wound was still draining some purulent fluid.

*Comment.*—I report this case more in detail because of the technical difficulty which presented itself at exploration and because the outcome was successful, despite forced resection. When this man came to the clinic there was drainage through the cecostomy opening which had been made two years previously for obstruction, which at that time was subacute and for which he underwent an emergency operation. A diagnosis of carcinoma of the sigmoid had been made at exploration. Metastasis had not been in evidence. This former operation had been done elsewhere. In the two years he had lost only 10 pounds in weight and had had little discomfort except for discharge of mucus from the rectum; feces or gas, so far as he knew, had not passed. His general condition was rather satisfactory, but he had a large tumor which was diagnosed as a fecal impaction,

filling practically the whole abdomen. It was impossible to relieve any of this tumefaction by irrigations, and an exploratory operation was decided on because of the patient's excellent condition, despite his having harbored a malignant neoplasm for two years. Through a long rectus incision the exploration was carried out. On opening the abdomen this huge, obstructed colon, which was filled with feces and which could not be emptied with a trocar, was delivered outside the abdomen. Consequently I was confronted with a difficulty which necessitated removal of the colon, for I could not get it back into the abdomen and close the abdominal wall, nor could I relieve its distention by trocar. Therefore I did a hemicolectomy from the middle of the transverse colon down to the rectosigmoid juncture, leaving clamps on both ends. This was a satisfactory procedure because of the drainage operation of cecostomy already established and there was no doubt that self-vaccination over a long period of time would assist in the prevention of peritonitis. After a fairly uneventful convalescence the patient was dismissed to go home. I have been in communication with him since. The cecostomy opening is still present, and the lower end of the sigmoid, on which I left a clamp, still drains from the lower angle of the wound. This is irrigated through and through by placing a tube in the rectum and another in the colostomy opening, and he reports a comfortable and satisfactory existence. Of course, the right half of the colon, to just beyond the hepatic flexure, is present. Evidently, however, it is not filling up with material to form another tumor similar to that which was present in the left colon, and the idea of joining the small bowel to the top of the rectum, although still viewed as a possibility, would very likely be an unwise venture. The man is aged sixty-four years; his health has been satisfactory for more than a year after the resection, and I believe it is discrete for him to abandon the idea of further operative procedures, since he harbored an encircling carcinoma for two years. The production of the huge megacolon, which corresponds identically with the infantile type of Hirschsprung's disease, is of sufficient interest to warrant reporting it in detail.

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# COMPLICATIONS FOLLOWING SURGICAL PROCEDURES ON THE COLON

FRED W. RANKIN AND GEORGE F. EUBANKS, JR.

RESECTION of the colon, segmental or otherwise, and by single or graded procedure, is universally accomplished with relatively high mortality which is due in many instances to the unfortunate complications which frequently follow surgical attack on the large bowel. This may be explained in some degree by the fact that these patients are often in the later decades of life and harbor a malignant growth in the large bowel which has undermined an already inefficient resistance and predisposed the cardiovascular and renal systems particularly to break down, at the same time enhancing chances of pulmonary complications if the patients must necessarily be confined in bed for any length of time. Technical difficulties of the operations themselves which are demanded frequently offer satisfactory explanation for postoperative complications, and the fact that we are dealing with an organ which contains many strains of bacteria, any of which is capable of causing peritonitis if contamination takes place during the operation, likewise predisposes to infection because of the increased permeability of the wall of the bowel at the site of the malignant growth or the greater ease with which organisms travel into the adjacent tissues, due to the injury to the mucosa which follows ulceration.

Peritonitis is the most formidable complication which confronts a patient requiring surgical procedures on the colon for malignant growth or for diverticulitis. Its incidence is remarkably higher in this type of surgery than in gastric or pelvic surgery because of the anatomic conformation of the large bowel and its normal bacterial content. The ease and frequency with which organisms may be squeezed out into adjacent tissues during operation, particularly when mobilization of an attached

or adherent growth necessitates a more or less difficult technical maneuver, multiply the chances of infection which may already have been present, but awaits trauma and manipulation to bring out peritoneal contamination. Gross contamination because of some technical difficulty at operation frequently occurred before the more routine application of aseptic operative procedures in resection of the colon, but it is questionable whether the major part of the infection was due to contamination from this source. Inaccessible lesions, requiring handling, and particularly lesions in fat persons in whom infection, both malignant and inflammatory, spreads rapidly, offer multiple opportunities for contamination, with its frequently fatal outcome.

On the left side of the colon the blood supply is not so regularly distributed as on the right side, and occasionally one finds necrosis following resection due to inadequate vascularization. Leakage at the suture line is not common except in cases in which one may not be sure of the blood supply to the divided ends or in fat persons in whom accurate suturing is not entirely satisfactory. Distention by gas postoperatively sometimes causes strain on the line of suture with resultant injury and leakage, but this is rare since one-stage operations are no longer in vogue and graded procedures are considered the maneuver of choice. Peritonitis following resection of the colon usually is of a fulminating type and is probably due to the weakened and undermined resistance which one finds in the anemic, debilitated, and desiccated patients who harbor neoplasms for any length of time. Particularly does the flora of the right half of the colon become virulent in the presence of long-standing growths. Growths of the right side of the colon are marked clinically by the profound anemia which accompanies them and which is due probably to injury to the mucosa or to impaired function secondary to large, ulcerating, fungating tumors which rarely cause obstruction, but which, being in the absorbing portion of the large bowel, are ideally situated to undermine its functional responsibilities.

The prevention of peritonitis necessarily is just as important as its treatment following operation. This may be brought about

in several ways, but we have found that it may be accomplished more satisfactorily under coöperative management and the isolation of colonic cases in a single unit. Preoperative preparation aims in reducing local infection either by irrigations of the bowel and purgation so as to overcome chronic or subacute obstruction, or by building up the patients by the institution of proper dietary and rehabilitation measures. Overcoming the anemia, increasing the fluids, and feeding a high calorie diet which at the same time is as free from residue as possible, have enabled us, we believe, to reduce the potentiality of peritonitis to a smaller percentage of cases.

We have also found of probable value the institution of treatment with vaccine of colon bacilli and streptococci intraperitoneally before operation. Following the experimental work of Herrmann, who produced a degree of immunity in dogs by the injection of strains of these organisms and succeeded in reducing the incidence of peritonitis, we began using this vaccine in clinical cases with eminently satisfactory results. The vaccine is administered first in a small dose subcutaneously to gauge the patient's susceptibility and subsequently in larger doses intraperitoneally with the idea of building up resistance to subsequent peritonitis. These injections, two in number, in the week prior to operation are followed uniformly by rather severe reactions, consisting of local tenderness and rigidity in the region of the injection, rise of temperature to 101° to 103° F., with general malaise and discomfort. The reaction passes off promptly and is followed within twenty-four hours by a feeling of well-being and satisfactory progress in the patient's condition. Without exception there has been leukocytosis and an increase in hemoglobin in these cases, suggesting that the vaccine may be a stimulant to the patient's recticulo-endothelial system.

We believe that aseptic operative procedures following satisfactory preoperative preparation increase markedly the likelihood of avoiding peritoneal contamination. The evaluation of the place which aseptic technical attack on colonic lesions occupies has yet to be decided, but unquestionably this type of resection has certain advantages, and in our hands it has proved

valuable. It is unquestionable that absolute rest to the gastro-intestinal tract for the first few days following resection is highly desirable to prevent spread of local contamination if present. This undoubtedly is accomplished best by the use of spinal anesthesia at the time of operation, thus producing paralysis of the entire gastro-intestinal system for twenty-four to forty-eight hours postoperatively and, in addition, by withholding from the stomach postoperatively for seventy-two hours all food or liquid, supplying the latter by venoclysis or hypodermoclysis.

Postoperative ileus is not a common complication and is due generally to adhesions to raw surfaces left at operation or to strangulation of the bowel by a loop slipping through behind the colostomy opening or into some fossa where it is not readily removed by its peristaltic activity. Usually postoperative ileus which is not due to actual mechanical obstruction is due to a mild type of peritoneal contamination which subsequently clears up under vigorous treatment, but if accompanied by distention, nausea, vomiting, and other evidences of mechanical blockage the condition demands exploration.

Parotitis of varying degrees of severity is seen rather frequently in patients who are not taking anything by mouth. This will usually manifest itself by painless enlargement of one or both parotid glands on or about the third day after operation. As the condition progresses the enlargement may become quite painful and suppuration may occur with the formation of abscess, requiring surgical drainage. Here again the treatment is largely prevention. All patients who are not taking liquids by mouth are given slices of lemon to suck and gum to chew. Also special efforts are made to keep the mouth thoroughly clean by frequent rinsings with some alkaline mouth-wash. Ice-bags are kept on the cheeks continuously if any enlargement appears. Since this treatment has been instituted we have not seen a case of suppurative parotitis and only one or two cases in which there has been any enlargement of the gland.

Wound infections after operations on the large bowel are of much more frequent occurrence than is usually admitted. Accu-

rate figures on the exact number on our service are not available, but a relatively high percentage of the wounds either drain serum or exhibit frank infection. This is the result of the necessary drainage operations which precede the resection. Wounds made for ileocolostomy, colocolostomy, or operations of this type are rarely contaminated unless one handles the growth considerably during exploration, but the secondary operation at which the growth is mobilized and removed is followed by a high percentage of wound contamination because of the presence of organisms in the thin-walled bowel and their spread by direct contact. In spite of the most vigorous efforts to avoid wound contamination in these cases the results have been uniformly unsatisfactory in this respect, and yet contamination is usually of a mild type and not due to a virulent organism. On the other hand we have had two cases, the direct result of contamination in the abdominal wall, where the infection spread laterally and upward despite our efforts, and continued to a lethal termination.

Occasionally a gas bacillus infection is reported following resection of the colon. Haggard and Stone have each recently reported such a case which they treated satisfactorily by injection of vaccine. In our experience we have not seen such a case, but the possibility of contamination of this type is always present. We have found that drainage of subcutaneous tissues down to the fascia with subsequent irrigation is a not unsatisfactory method of preventing some of these contaminations with the later developing herniation. Heat by an arc of carbon filament lamp or by hot dressings is employed early before the infection becomes evident. Attempts to seal off the separate incisions from the old colostomy wound by collodion and adhesive tape have, in our experience, been satisfactory.

Following posterior resection of the rectum the wound is always infected to a greater or less degree, depending on the preparation of the operative field and the care of the wound. If the field is adequately prepared before operation and the anus is closed by an encircling suture of fishline, the local avenues of infection are reduced to a minimum. However, the large

pocket which is left after removal of the rectum must fill in by granulation and it is very difficult to prevent infection of some type or degree. Occasionally one may wash out these fossæ with a solution of carbolic acid or some such antiseptic and by closure succeed in making a primary union; in our experience this is what occurs. Because of the likelihood of post-operative oozing it has been found satisfactory to put one or two strips of gauze, either iodin or vaselin, through this fossa, and after removing them on the third or fifth days, begin irrigations of either permanganate of potash or physiologic solution of sodium chlorid. Thirty cubic centimeters of dichloramin-T is instilled into the depth of the wound through the drainage-tube after irrigation and the procedure repeated three times a day until the wound is healing satisfactorily. On about the eighth day after operation the patient is placed in a hot sitz-bath twice daily and this is continued as long as hospitalization is demanded.

Colostomy and appendicostomy wounds are rarely the site of infection, usually healing by primary intention.

Bleeding postoperatively occurs occasionally following posterior resection or an abdominoperineal type of operation despite the utmost care and precaution at the time of operation, and especially if one is inclined to the use of spinal or sacral anesthesia. Its avoidance is impossible in all cases, but the drainage from the wound should be watched carefully and at the first symptom of bleeding the wound should be opened and the bleeding points sutured. If the hemorrhage is the result of general oozing, packing with gauze may suffice. It is a complication which should not be followed by unhappy results if the surgeon is alert in the postoperative observation of his cases.

One unusual complication which we record and which has been an isolated incidence in our experience is the development of a small intestinal fistula following a secondary operation of the colon after removal of the rectum by posterior resection. This occurred after removal of the rectal stump by posterior operation necessitated by recurrence in the stump after anterior resection of the rectosigmoid had been made for carcinoma. The stump was excised posteriorly and a loop of small bowel

which had become adherent in the pelvis after the first operation was observed, but not opened. Evidently it was injured, because on the third day there was slight drainage from the bowel and this continued for a period of three weeks. The patient died on the twenty-fourth postoperative day of inanition and dehydration.

Other less common complications which may properly be classified as surgical complications are obstruction and pulmonary embolism. There is probably no more tragic termination to an otherwise uneventful convalescence and none that is more difficult to explain satisfactorily to relatives of the patient than fatal pulmonary embolism. No form of treatment in our hands has proved to be of any value in this type of complication either as a preventive or curative measure.

The most common so-called medical complications which we have met after operative procedures on the colon are pyelonephritis and pneumonia. Many patients with surgical lesions of the colon are elderly and many of the male patients have more or less prostatic hypertrophy. These patients often require repeated catheterization after operation. Unless this procedure is carried out under the most meticulous aseptic precautions in this type of case the introduction of a catheter will cause ascending infection of the genito-urinary tract, and if it is not given prompt and proper attention may result fatally. We have made it a practice to irrigate all retention catheters twice daily with 1 : 5,000 solution of potassium permanganate, instilling from 30 to 60 c.c. of 2 per cent mercurochrome into the bladder after each irrigation. Catheters are changed every five days and they are removed entirely as soon as there is no residual urine after voiding. The fluid intake of all patients is kept between 2,500 and 3,500 c.c. daily unless there is edema or other evidence of renal insufficiency necessitating reduction in the fluid. Sodium acid phosphate, hexamethylenamin, and euphyllin in 0.2-dram doses are used in an effort to increase the output of urine and to control the infection. It has occasionally been necessary to resort to anilin gentian violet or mercurochrome intravenously to control the infection. Ten per cent glucose in

sterile water given intravenously often acts as an efficient diuretic.

Bronchopneumonia has occurred less frequently since we have used spinal anesthesia rather than ether. When this does develop it is treated by building up the general resistance of the patient, increasing the fluid intake by intravenous injections of glucose and physiologic solution of sodium chlorid, steam and compound tincture of benzoin inhalations, terpene hydrate with heroin in 1 dram doses, and, if respiration is markedly embarrassed and cyanosis develops, the use of the oxygen chamber or the oxygen tent.

We try to prevent the development of hypostatic congestion in the chest by keeping all elderly patients in Fowler's position in bed and by getting them out of bed as soon as possible. The treatment of this condition is much the same as that of bronchopneumonia except that the patient is gotten out of bed if the wound can be sufficiently supported to permit.

Despite the usual high mortality and frequency of complications under certain conditions, surgical procedures on the colon unquestionably have been advanced by coöperative management, and not only has the mortality been reduced to within reasonable limits, but the postoperative complications likewise have been fewer. Much progress remains to be made in surgery of of the large bowel and rectum, and it is with this in mind that the individualization of patients, better selection of operative cases, better understanding of the grading of malignancy and more careful consideration of the desirability of treatment by radium has been instituted in our service.

# CERTAIN FEATURES OF LOCAL ANESTHESIA FOR TONSILLECTOMY*

HAROLD I. LILLIE

MANY significant factors are involved in the successful use of local anesthesia in performing tonsillectomy. So much has been said concerning the dangers of the procedure that in certain localities the method is rarely used. As a matter of fact, local anesthesia can be used successfully in performing tonsillectomy; it is practical and relatively safe, and is followed by few complications if the method, the environment, and the circumstances under which the operation is performed are adapted to its use. Successful local anesthesia for tonsillectomy involves more than merely injecting an anesthetic solution in or around the fauces and waiting a certain length of time for the drug to take effect. Better methods of using local anesthesia for tonsillectomy have resulted from adopting the best features of technic from the experience of careful observers. There is still much to be desired.

There are several important factors in local anesthesia for tonsillectomy including the personalities of the surgeon and the patient, the environment, and the method.

**The Surgeon.**—Some surgeons do not use local anesthesia successfully because they are unfitted to do so. Unfortunately, there are some who do not realize, or will not recognize their limitations, and as a result of this experience condemn the method for others. It is necessary and important that the surgeon have confidence in his own ability, so that he may instill a feeling of confidence in the patient that he can perform the operation successfully. Under these circumstances the under-

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current of uneasiness or dread is relieved to a large degree immediately and the patient and surgeon stand on common ground. In such a case the surgeon is calmly at ease, as dignified as the situation may demand, pleasant, cheerful, kind, adaptable, and resourceful, for he must be in control of the whole situation. Uneasiness, fretfulness, or excitability do not instill confidence. What could be more tragic than an irritable, incompetent surgeon operating on an excited, resisting, noncoöperating patient?

**The Patient.**—The patient is about to subject himself to an unpleasant experience because of possible benefits to his health. He knows or, at least if he had made inquiry, he has been advised that there is always an element of danger in any operation even under the best conditions. The human being has an intellect. Persons have been known, or have been said, to have died from fright; therefore it is incumbent on the surgeon to control the emotions. In my opinion, there is great fallacy in drawing conclusions concerning the effect of drugs from experiments on laboratory animals like the frog, because the reactions and emotions of the human being are much more complex.

My experience with patients who are subjected to operations under local anesthesia leads me to believe that they fall into four main groups determined by personality, and emotions and that those in each group must be handled quite differently. It becomes relatively easy to classify patients to one's own satisfaction before operation, and to be forewarned is to be forearmed.

In the first group, the patients are intelligent, unafraid, confident, and submit to operation in a spirit of complete cooperation, both mental and physical. The pharyngeal reflexes are easily controlled and suggestions are obeyed exactly, even in spite of any annoyance. Operation is easily performed even though some technical difficulty may arise. The surgeon, outwardly at least, must be perfectly at ease.

In the second group the patients are of the same general mold as in the first group except that, despite their efforts, there is difficulty in controlling the pharyngeal reflexes. This adds to

the technical difficulty of the operation. The patients realize the condition and invariably say that they are sorry and that the surgeon should proceed. The surgeon pays little or no attention to the pharynx and performs the operation as expeditiously as possible; usually these patients are most appreciative.

In the third group are the nervous, fearful, perhaps tearful patients. Try as they may, they have little control over their emotions. Realizing this, they increase the difficulty. They have confidence in the surgeon, but are still afraid. Under these circumstances local anesthesia is not complete without "vocal" anesthesia, that is, the surgeon must be kind, buoyant, and gentle. To relieve the tension he may joke with the patient, or at least make an effort to make him smile. A continuous line of chatter while he works often has a good effect; whistling softly or singing may entirely relieve the situation. What might be called a scientific indifference on the part of the surgeon to the psychic reaction of the patient often relieves what otherwise might be a serious situation. Too much dignity, an evidence of uneasiness on the part of the surgeon, will add greatly to the difficulties. After operation the patient's frame of mind is entirely changed.

In the fourth group are the purposely noncoöperative, sullen patients. The attitude may be the result of fear, but it does not seem an obvious cause. Under such circumstances the surgeon must be stern and exacting rather than cheerful and buoyant. The operation is occasionally an ordeal for both patient and surgeon.

**Indications for Local Anesthesia.**—The choice of anesthesia for tonsillectomy should not be left entirely to the patient's judgment, as the surgeon knows whether operation can be performed more satisfactorily under local or general anesthesia, and it should, therefore, be his prerogative to designate the anesthetic. This should not be done in dictatorial manner, but rather by persuasive reasoning. The greatest objections patients have to local anesthesia is that they are afraid there will be too much pain, or that they do not wish to realize what is taking place and prefer to be asleep.

At The Mayo Clinic local anesthesia is used for tonsillectomy in many adolescent and all adult patients. General anesthesia is used only for children. During the last eleven years tonsillectomy has been performed in about 35,000 cases under local anesthesia. Tonsillectomy is performed because of local pharyngeal symptoms and findings, or for the removal of foci of infection if the patient's general physical condition makes it desirable.

The youngest patient operated on under local anesthesia was eight years of age and the oldest was eighty-four. The latter gave a history of repeated definite attacks of tonsillitis during later years, but had been refused tonsillectomy on account of advanced age. He lived for several years and was free from tonsillitis.

Tonsillectomy is not, and should not be, a sleight-of-hand performance. Under certain conditions operation can be successfully accomplished quickly by certain ingenious contrivances, but it is not generally considered good surgical technic.

Under local anesthesia the operations may be performed rapidly if conditions permit. If disease of the tissues makes it desirable to work more slowly there is no occasion for hurry, as the anesthetic effect will last over a sufficient period. If necessary, more anesthetic solution may be used.

Whenever it is felt that improvement in the patient's general condition may result from removal of infected tonsils, there seem few if any contraindications so far as the general condition is concerned. This is said because it has fallen to our lot to have tonsillectomy insisted on by the internist in many cases in which the surgical risk is great. Angina pectoris, endocarditis, arthritis, essential hypertension, nephritis, nephrosis, chorea, various types of dermatosis, purpura hemorrhagica and the like, of varying degrees of severity have been present in cases in which tonsillectomy has been performed successfully. One operative fatality occurred in a case of syphilis of the central nervous system in which antisyphilitic treatment had not been tolerated because of focal infection. The heart was not in diastole at necropsy. Four patients developed infarction of the lung, in

two of which empyema necessitated surgical treatment; the others recovered without interference.

**Contraindications to Local Anesthesia.**—Children can scarcely be expected to coöperate with the surgeon and are, therefore, not suitable subjects. Occasionally it is possible to use the method in operating on certain of the more stable type of children, but there seems to be no particular advantage in this.

Idiosyncrasy for the drug to be used, if it really exists, which I doubt, would be a contraindication. Cocain or its derivatives does not cause immediate death in animals even in lethal doses. Certain psychic reactions, pallor, syncope, petit mal, and the like, are misinterpreted too frequently. If, under these circumstances, the surgeon becomes excited, and allows the situation to get out of his control, the effect is tragic. Certain patients had been told that they had an idiosyncrasy for local anesthesia, but they underwent operation without incident. One striking example shows the "effect of mind over matter." A middle-aged woman, a nurse, presented herself for tonsillectomy because of repeated attacks of tonsillitis and peritonsillar abscess. On three previous occasions tonsillectomy had been unsuccessful. She had been told that she had an idiosyncrasy for cocain because of certain psychic manifestations at the time of the attempted operations. She warned me three different times. I had tested her by using some cocain in the nose without incident, and felt that the idiosyncrasy was more mental than real. Operation was performed entirely without incident; the patient did not know what solution was used. The next morning, on visiting her, it was suggested that she had done very well, to which she assented. She asked what solution had been used, and when told that it was the regular cocain solution, she fainted. Many experiences with patients who have been told that they had an idiosyncrasy for cocain and its derivatives lead me to believe that many physicians and surgeons misinterpret symptoms and signs.

Tonsillectomy should not be performed under any circumstances in the presence of true hemophilia. The history and laboratory data will rule out this group of cases. Tonsillectomy

should not be performed if patients are in poor physical condition if there is a reasonable doubt as to benefits to be derived. Old age itself need not be a contraindication to tonsillectomy.

**The Environment and Preparation of the Patient.**—When tonsillectomy has been decided on and the patient has been submitted to a general examination, so that the surgeon may be forewarned of any serious contraindication to operation, the patient is sent to the hospital the evening before operation. This has been found advisable in order to place the patient more at ease and allow him to become accustomed to his surroundings.

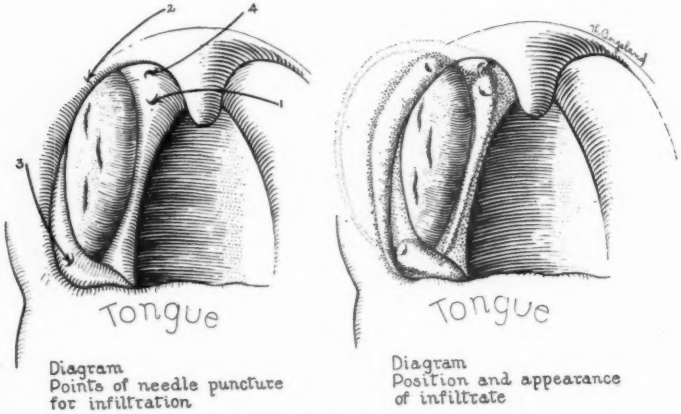


FIG. 321.

The temperature is checked the evening before and the morning of the operation. The morning meal is omitted and the patient is given a hypodermic injection of $\frac{1}{8}$ grain of morphin sulphate and 1/200 grain of scopolamin hydrobromid about one hour before operation (Fig. 321). The combination of drugs relieves much of the mental anxiety that patients usually manifest. Scopolamin has replaced atropin because it has been found that it has a better effect on the sensibilities, and the effect of controlling the secretions in the pharynx is the same. The 1/200-grain dose has been selected through experience; 1/100 or 1/150 grain was found to be too effective in certain cases. If the effect

of the hypodermic is more pronounced than necessary (this happens only occasionally) the operation can be delayed until the following morning and the hypodermic injection be omitted.

**The Operating Room.**—It has been found best to usher the patient into the operating room without the use of wheel chair or any other conveyance so as not to break down a sense of personal reliance. There must be an atmosphere of cheerfulness in the operating room. The surgeon, assistants, and nurses should show no signs of anxiety if any is felt. The patient is seated in the upright position in a chair suitable for operation and calmly instructed how to coöperate. If pallor, syncope, or petit mal is manifested, it is largely due to emotion, and the patient's head is placed between his knees until he feels better. In a surprising number of such instances the patient expresses embarrassment because of his inability to control his emotions. The symptoms are the result of emotion, as no anesthetic has been used. Symptoms may follow the injection, but are more likely to occur before. The patient, considerably reassured because nothing has happened, is instructed to relax completely and to breathe through his mouth. Short breathing tends to relieve the pharyngeal reflexes. In fact, it gives the patient something on which to center his attention and it is his particular part in the operating technic.

**A Method.**—For injecting the anesthetic solution a needle of small caliber at any angle of 45 degrees is satisfactory. The first injection is into the posterior pillar between the capsule of the tonsil and the aponeurosis at the highest point. The injection is made slowly so that infiltration will result rather than the formation of a bleb. If the infiltration does not proceed through to the lowest part of the pillar, it should be followed down. The next infiltration is in the uppermost part at the anterior pillar. On piercing the pillar one must feel that the needle is perfectly free. The same slow infiltration is preferable and it will be seen to extend along the pillar to the edge of the tongue. The next infiltration is in the plica triangularis. This is accomplished by changing the direction of the needle toward and longitudinally with the edge of the tongue. The lower pole of the tonsil is more

shallow than the upper pole, therefore there is greater danger of penetrating the aponeurosis and causing deep cervical infection. There is no need of injecting the tonsil itself. Infiltration at this point is carried slowly around the lower pole. Attention is directed to the fact that cocainization by swabbing of any part of the fauces, pharynx, or tonsil has not been found necessary. Patients make practically no complaint of the insertion of the needle if it is sharp. Both sides may be infiltrated before the operation is started. The tonsil may now be seized with any suitable forceps and pulled rather strongly toward the median line and down toward the tongue. This outlines the upper pole. The needle is inserted into the supratonsillar fossa at the margin of the tonsil and mucous membrane. The injection of the solution is carried on slowly so that infiltration will take place. It might be added that as much solution may be used as is necessary to surround the tonsil satisfactorily. Previous peritonsillar inflammation may interfere with the infiltration because the loose tissue has been replaced by scar tissue. In such instances infiltration may be repeated as often as necessary when limits of infiltration are encountered. It is particularly important that the injection of the upper pole be carried on carefully, for unless one knows the position of the upper pole, the landmarks may be obscured and considerable difficulty encountered in the enucleation. The point of entrance of the last needle insertion is a constant landmark. After removal of the tonsil it is seen that there is no evidence of the solution remaining, as it has merely surrounded the tonsil and has been removed with the tonsil.

It makes very little difference what method is used in removing the tonsil. There are as many good methods as there are good surgeons operating on tonsils. Following operation the patient is returned to his room by means of a wheel chair.

It would appear that the advantage of local anesthesia is in the coöperation of the patient. In the upright position the anatomic relations are the same as they were on examination; there is less operative bleeding and ample time to control it; the Bechic reflex is not abolished; no assistant is required other than a nurse; there is ample time to perform the operation satis-

factorily, and the patient can more easily be instructed in post-operative care and can readily follow instructions given him. As has been said, there seem to be few contraindications for the use of this method of local anesthesia.

So far as I am concerned, there is little choice in the solution to be used for the production of local anesthesia. Sodium chlorid solution has been used several times satisfactorily, as it is felt that the pressure caused by infiltration produces as much anesthesia as the solution itself.

# BENIGN TUMORS OF THE COLON

LOUIS A. BUIE AND THEODORE SWAN

TUMORS of the colon are much less frequently benign than malignant, but benign tumors probably occur more often than generally is thought. Their apparent rarity is enhanced by certain factors. Many remain symptomless until they have assumed proportions sufficient to interfere with normal, mechanical function of the bowel, or until they produce such complications as invagination, intussusception, and consequent obstruction. Therefore it is conceivable that individuals have harbored such growths during their entire lives, have never had symptoms from them, and have died from other causes, with the growths undiscovered. A generation ago the passage of a few drops of blood from the anus meant only a "case of piles" and, unfortunately, it often means little more than that now in the minds of many.

However, many tumors are being discovered now by examination with the proctoscope or sigmoidoscope and by fluoroscopic examinations, all of which may be made in the course of routine periodic general examinations. Facilities exist by which it is possible to expose to direct scrutiny 25 cm., and often more, of the rectum and sigmoid. When necessary this information can be supplemented by roentgenography after administration of a barium enema. In the clinic during recent years the policy has been to submit to proctoscopic and sigmoidoscopic examinations all patients who complained of a condition suggestive of functional abnormality of the bowel or in whom indication for such examination was found in the routine digital examination of the anus and rectum. Since 1924 (and up to August 15, 1928) proctoscopic or sigmoidoscopic examinations have been made on 19,103 patients. Polyps were found in 455, an incidence of

2.38 per cent. It was not always possible to determine the significance of the lesion as a symptom producer. However, it would be safe to estimate that at least half of them were discovered incidentally, had produced no symptoms, and never would have been discovered if the routine complete examination had not been made. Thus we believe that these benign growths will appear to increase in frequency in proportion to improvement in diagnostic efforts.

About two-thirds of the benign growths involving the intestines are in the colon. In Dewis' series, 154 of 219 such lesions (70 per cent) were found in some part of the colon. In Leichtenstein's series of 128 benign intestinal tumors, eighty-nine (69.5 per cent) were located in the colon.

The object of this paper is to present information gained from a study of fifty-two benign colonic growths found in patients examined at The Mayo Clinic from 1905 to 1926.

According to the usual classification of such tumors the types and the number of cases of each type may be grouped as follows: Adenoma, nineteen; adenofibroma, two; fibroma, one; lipoma, eight; adenomyoma, five; fibromyoma, one; angioma, one; polyp, thirteen, and cystic tumor, two. All of these growths were located in the colon. However, rectal growths are excluded from this paper because the subject of benign rectal growths is worthy of consideration by itself in a later article. Benign tumors affect the rectum more than the entire remaining portions of the large intestine. In Dewis' series, 65.5 per cent of the colonic lesions occurred in the rectum, and in Leichtenstein's series, of eighty-nine growths found in the colon, seventy-five (84.2 per cent) were in the rectum.

**Adenoma.**—Simple adenomas occur more frequently than any other type of tumor. Had present-day diagnostic facilities been available during the years from 1905 to 1922, the number of such lesions found would have been greatly in excess of the figure recorded in this series. Polyps found in association with malignant growths and chronic ulcerative colitis are not included in this group.

Most polyps are adenomatous, with varying amounts of

fibrous tissue as a part of their structure. Those in combination with myomatous tissue are not so common. Grossly they are either sessile or pedunculated and their size varies within wide ranges. Sessile polyps may be found as small as a millimeter in diameter and masses of polyps may involve a complete segment of the bowel. Their color varies from pale pink to very dark red. Ulceration, bleeding, necrosis, and strangulation all modify the appearance. There is a very narrow margin of differentiation between malignant and benign types, and the only way of determining the nature of one of these polyps is by careful microscopic examination. A single section or several sections from such a growth, studied microscopically, may not afford conclusive proof of the character of the tumor. Benign adenomatous tissue may appear in many sections, but in the twentieth section cells may be found breaking through the basement membrane. It is manifestly impossible to satisfy the requirement of exhaustive study by biopsy. To protect the host all polyps should be regarded as potentially malignant and should be eradicated. This may seem an extreme measure to apply to the smallest of sessile polyps, but they can be disposed of so easily that they should be removed.

Small sessile polyps, especially when found high in the rectum or in the sigmoid, require particular attention during examinations. We have found cancers or diverticulitis so frequently associated with them that we examine the bowel particularly diligently when they are present. If no other disorder is found on inspection with instruments, we make a roentgenogram after injection of a barium enema. Our efforts have been so fruitful in such instances that we have learned to regard these little innocent-appearing lesions as sentinel polyps.

The symptoms produced by adenoma of the colon depend chiefly on the size and situation of the lesion and the presence, or absence, of inflammatory change or ulceration. When the growths are in the ascending or transverse colon the first symptoms often are those of obstruction. In the sigmoid such growths are always more productive of discomfort and of derangement of function. A sense of fulness, dull pain or soreness

in the left part of the abdomen are common. Constipation increases these discomforts. With growths in the lower part of the colon urgency and frequency of desire to defecate, with unsatisfactory and incomplete small stools, occur. This frequency is to be distinguished from true diarrhea, although the latter may occur when the polyps are multiple and ulcerated. Sometimes, when there are great numbers of polyps and ulcers in the lower third of the colon, the diarrhea may be comparable to that associated with malignant lesions. Mucus is a constant product of adenomatous polyps, and when the wall of the bowel is diffusely involved this secretion is very abundant. Bleeding develops with ulceration, or as a result of traumatic breaks in the surface of the growth. Usually bleeding is small in quantity, but entire polyps have been known to slough off with accompanying profuse hemorrhage. Tenesmus is not associated with lesions of the right half of the colon, but when growths are in the left portion and especially if they are in the sigmoid tenesmus is more often present than absent. Usually there is no loss of weight and although anemia may be present it is usually very mild.

Unless the tumor is large enough and firm enough to be felt there is little to be learned by general examination. There may be slight discomfort on pressure. Of the nineteen cases of adenoma in this series, roentgenographic examination revealed a lesion in four cases and a spastic sigmoid colon in six; in six others abnormalities were not found, and in three roentgenographic examinations of the colon were not made. In fifteen cases the lesion was seen through the sigmoidoscope and seen well enough for the examiner to give a detailed description of the growth. Three patients were not examined in this manner; in one the lesion was too high to be seen and was outlined in the roentgenogram. Polyps often have a long pedicle and invagination of the bowel often results from the downward pull of the feces. Therefore frequently it is possible to diagnose such lesions through the sigmoidoscope even when their points of attachment to the wall of the bowel are many centimeters above

the place where the polyps are seen and beyond the reach of the sigmoidoscope.

Adenomas present a gland-like structure with many branching acini which are lined with high cylindrical epithelium. According to Tuttle, the "soft mucous" variety which "arises in an inflamed solitary follicle" is most common. "It consists," he says, "of alveolar tissue, the meshes of which are filled with a thick viscid fluid; the surface is covered with cylindrical epithelium, and sometimes it contains true Lieberkuhn tubules. Occasionally the mucous glands of the intestinal wall are dragged into the tumor in the process of formation and they may appear therein as small cysts." This type of tumor is not the true adenomatous polyp. It contains less of the gland-like structure and more of the reticular network with deposits of a gelatinous substance and should be classified as a myxoma.

The origin of these growths has not been satisfactorily proved. The theory advanced by early writers, and accepted by many, is that they begin in the glands of Lieberkuhn. It would seem, however, that the regenerative layer of cells in the mucous membrane itself would be just as capable of producing such abnormal cellular developments.

**Adenofibroma.**—Adenofibromas, of which there were two in this series, are in reality adenomas with a large amount of fibrous stroma. In general, the same considerations apply as those which apply in adenoma.

**Fibroma.**—Fibromas are extremely rare in the large bowel. In 1886 Jansen reported a hard, mobile tumor about 8 cm. in diameter in the descending colon of a woman thirty-five years of age. The mass was successfully resected and was found to be a true fibroma. Faure and Deplas reported a fibroma of the cecum about 15 cm. in diameter in a woman twenty-three years old. In 1913 Patel stated that three cases of fibrous tumors of the large bowel had been met with, and it is probable that the two mentioned above were of the three he had in mind. Pennington refers to another which he claims was overlooked by Patel; the case was that of a man aged twenty-eight years and was reported by Molliere in 1877. This tumor was extruded

through the anus, was ligated, and was excised, with the resultant loss of the patient's life. At necropsy the fibrous growth was found to originate in the pelvic colon. In 1917 King, with the permission of W. J. Mayo and H. S. Plummer, reported the case we have included here.

These four cases are the only true fibromas of the colon reports of which we found in the literature previous to March, 1927, unless the case of Legue is included. Legue's patient had a fibroma on the ileocecal coil which apparently took its origin in the subperitoneal connective tissue, external to the muscularis. The patient was a woman thirty years of age who had undergone appendectomy two years previously. Since her trouble was intimately associated with a history of appendicitis one might conjecture that there was some relationship between the two conditions. The one fibroma in this series, originally reported by King, occurred in a young man seventeen years of age. He received an injury in the right lower quadrant of the abdomen while pitching hay. Immediately following this accident there was a rapid growth of a mass in that area. He presented himself for examination for this reason only, and on close quizzing he denied the existence of any subjective symptoms. He had never passed blood, had not had diarrhea, and there was no discomfort or abnormality of function. In two weeks he had lost 14 pounds. General examination was negative except for a palpable firm, oval, freely movable tumor, measuring about 7.5 by 12.5 cm. The hemoglobin was 80 per cent and the leukocytes numbered 13,200. At operation a tumor about 5 cm. in diameter was found involving the cecum and ascending colon. A resection was performed and the patient recovered satisfactorily. Microscopically very few cells were present. The matrix, which was extremely dense and firm, formed the bulk of the tumor.

**Lipoma.**—In 1906 Dewis reviewed forty-four cases of lipoma of the gastro-intestinal tract, in two of which the tumor was in the cecum; in five, in the colon other than the rectum or sigmoid, and in five, in the sigmoid. Lipomas commonly arise either from the submucous or subserous layers of the wall of

the bowel. Bland-Sutton pointed out that dimpling in the serosa of the large bowel, in the presence of chronic obstruction, may be caused by the traction exerted by a lipoma. Lipomas may cause intussusception, obstruction from size alone, or bleeding due to ulceration, and they may be extruded spontaneously. Intussusception occurs in 42.1 per cent of cases and spontaneous expulsion in 20 per cent according to Dewis.

Other benign tumors do not show this tendency to expulsion. Ninaus' classical case well illustrates this point. The patient was a man aged thirty-two years who had been ill for a month with severe abdominal cramps, especially over the cecum, and with distention and inability to have a bowel movement. Persistent vomiting developed, which later became fecal, and pus and blood were passed in the stool. After ten days he passed from five to seven foul-smelling stools daily, and on the twentieth day he passed a soft, flabby piece of small intestine, 120 cm. long by 10 to 12 cm. wide. To the inner side of this piece of bowel was attached a submucous lipoma.

Of the eight cases here reported, tumors were found at necropsy in two. The condition in one case was described as lipomatosis of the entire colon and rectum; another, as lipomatosis of the mesentery of the sigmoid. Fat tags on the serosa in both cases were greatly enlarged. In five cases, three in females and two in males, the growths were of the submucous variety; one was pedunculated, one was multiple, and one was associated with intussusception. The average age of the patients was forty-nine years. Four of the five had bleeding by bowel and this symptom was of primary importance in three. Three patients had a palpable mass in the abdomen. All complained of abdominal pain. Three had alternating diarrhea and constipation. Three at some time had had nausea and vomiting. A loss of weight, varying from 15 to 30 pounds, was noted in all cases. In two cases roentgenograms of the colon were made and a filling defect was noted in each case.

Lipomas vary greatly in size: they may be as small as 1 cm. in diameter and as large as 10 cm. in diameter. They may be sessile or pedunculated. Their origin may be from the sub-

mucous coat or from the subserosa. There may be inflammation and even ulceration, which explains the passage of blood in many cases.

Microscopically, the supporting structure of the tumor is seen to be composed of a framework of adipose tissue. The stroma is a little more irregular at times than that seen in normal fatty tissue. In one specimen the blood-vessels were numerous and large. Increased vascularity then might be an added reason for the bleeding noted in these cases. The most common cause of the bleeding in lipoma of the gastro-intestinal tract presumably is ulceration, but it might be possible that inflammation alone could cause gross hemorrhage. Three predisposing factors could be mentioned in support of this contention: (1) The poor support offered to the vessels by a thin stroma of fat tissue; (2) the great number of blood-vessels (more than are apparent to gross examination), and (3) the large caliber of the vessels in proportion to the area supplied by them.

**Adenomyoma.**—Five cases of adenomyoma were found, in all of which the tumor was situated in the sigmoid. In none of these was the tumor secondary to the same process in the uterus; that is, the symptoms were referable to the bowel in every case, and the tumor was not just an implantation on the sigmoid found during operation on the uterus. As Judd and Foulds have reported, the presence of these tumors seldom is diagnosed before operation. They occur in middle-aged women who have not recently borne children.

The symptoms are dull pain in the left lower portion of the abdomen. Possibly acute obstruction has occurred or perhaps chronic obstruction is present; bleeding by bowel may be a symptom. The symptoms are much worse at the menstrual period and blood and mucus may be passed by bowel in larger quantities at that time. The pain is more constant and persists between periods. A mass may be felt in the left part of the pelvis. Roentgenograms of the colon disclose a filling defect in the sigmoid portion. On proctoscopic examination narrowing of the lumen of the sigmoid portion of the bowel, without involvement of the mucous membrane, is seen.

Credit has been given to Spencer for original mention of adenomyoma of the sigmoid in 1913. The etiology has not been definitely decided. At first it was thought adenomyomas arose from inclusions of derivatives of Mueller's duct. This was followed by the theory supported by von Recklinghausen that these tumors are of mesothelial origin and are derived from the wolffian body. Bland-Sutton discredited both theories and agreed with Cullen who in 1896 advanced the idea that they arise in adult uterine mucosa. This theory has been most widely accepted. More recently Sampson has advocated the idea that epithelium from the uterus and tubes may escape through the fimbriated ends of the tubes and give rise to implantations on the ovary which acts as an intermediate host. Pathologists recognize carcinomatous implantations in the pelvic peritoneum and grant that the ovary is sometimes the seat of the primary lesion. Sampson claims that there is an analogous process in the spread of adenoma, with ovarian hematoma of endometrial type as the primary focus. He found perforating hemorrhagic cysts of the ovary in all of his cases, and Judd and Foulds reported that the same type of cysts were present in all but one of their cases. Similarly, cysts of the ovary were found in four of the five cases in this series; in the fifth case bilateral oöphoritis was found and both ovaries were removed. When the ovarian cyst ruptures implants again are extruded and the neighboring organs may become involved. Thus of eight cases in which the rectum or sigmoid was involved, in six the cyst was in the left ovary. The appendix contained adenomyomatous tissue in four cases, and in all four hematoma was in the right ovary.

This explanation of the etiology of adenomyoma which takes account of the ovary as a focus fits in very well with the clinical picture. Symptoms are more easily explained on the basis that such islands of uterine tissue grafted on the outer coat of the sigmoid carry with them the function of uterine tissue. As invasion becomes more advanced and extension occurs, the tumor may reach a large size and may penetrate the mucosa of the sigmoid. Hence blood is passed by bowel during menses.

The tumor may become large enough to produce obstructive symptoms.

Grossly, the tumors are solid; they are often gray and the adenomatous parts are bright silver and moist. When hemorrhage has occurred these areas take on a dark golden or brown hue. An infiltrative tendency may be seen. They may be subperitoneal, interstitial, or submucous. Microscopically there is a strong resemblance to endometrial glands and stroma. There are larger or smaller groups of acini lined by cylindrical or cubical epithelium. At times a double row of epithelial cells is seen supported by lymphoid stroma. The cells may be large, contain large nuclei, and stain deeply. Sometimes cysts are formed within the glands, and papillary projections have been seen extending into these. There may be evidences of hemorrhage in some sections. The stroma is endometrial in appearance; the muscle tissue may be greatly thickened and hypertrophied.

**Hemangioma.**—In 1924 Brown reviewed twenty cases of vascular tumors of the intestine. The case of Bennecke was that of a man fifty-two years of age who died of tuberculous meningitis. In the submucosa of the entire intestine, from esophagus to rectum, were small, brownish-red masses which proved to be hemangiomas. The case of Dujarier and Topous Khan was of a man who had been suffering from rectal hemorrhages for three years. At operation numerous cavernous hemangiomas were found in the sigmoid and there was marked varicosity of the veins in the tumors. Tuffier described an angioma in the sigmoid of a man thirty-one years old in whom fatal hemorrhage took place. He began to pass blood when he was seven years of age, in amounts up to about 250 c.c.; he had attacks at intervals of months and sometimes of years. Anemia developed and at one time he was treated for pernicious anemia. Tuffier advised sigmoidoscopy and found a small purplish tumefaction about 0.2 cm. in diameter, 22 cm. above the anus. This was slightly ulcerated and about it were several small areas which looked like nevi. The ulcerated area was cauterized; after this the patient seemed to improve for a time, but hemorrhage re-

curred. The sigmoid was then explored through an abdominal incision, but a tumor could not be found. At necropsy two small angiomas were found in the sigmoid beneath the mucosa and were about 0.2 cm. in diameter. These three were the only cases reported of hemangioma in the colon proper.

Hemangiomas were found in two cases in this group. In one case, that of a woman forty-seven years of age, the patient gave a history typical of disease of the gallbladder with stones. At operation the presence of stones in the gallbladder was confirmed. On examination of the appendix it was found to be involved in a process which extended over the entire base of the cecum and which had the appearance of hemangioma. The vessels over the lower 7.5 cm. of the cecum and appendix were very tortuous and beaded and formed a diffuse venous angioma, which seemed to arise from beneath the serosa, and was of the simple type.

The second case in this group was that of a woman forty-eight years of age who had been ill for four months. The onset of her symptoms was gradual, and the initial complaint was of a cramp-like pain in the lower left quadrant of the abdomen. On three occasions she had passed small amounts of blood, some of which was bright red and some dark. One month before she arrived acute obstruction had developed. To relieve this cecostomy was performed. On examination a hard irregular mass could be outlined in the left portion of the abdomen. Secondary anemia was present: the hemoglobin was 58 per cent, the erythrocytes numbered 3,720,000 in each cubic millimeter of blood, and the leukocytes, 10,400. On fluoroscopy a large filling defect was noted in the transverse colon, near the splenic flexure, and the roentgenograms revealed the same filling defect. Just above the point of stricture there was a rounded defect in the shadow highly suggestive of a benign lesion. At operation an annular cavernous hemangioma 8 cm. long was found.

In the twenty cases reviewed by Brown the sexes were equally represented. Intestinal obstruction was found in five cases, all in females. Five of the six patients exhibiting hemorrhage were males. The ages ranged from two months to seventy-

nine years. In twelve cases the tumor was single and in eight cases multiple. In three cases there was ulceration of the mucous membrane over the tumor. In all in which mention was made of origin of the tumor it arose in the submucosa.

Ewing stated that "angiomas take origin in a developmental anomaly in the structure of certain vascular segments which do not fit into the circulatory system, and which retain embryonal characters." Irritation of imperfectly formed vessels like those in embryonal fissures was the theory of origin of Virchow. Ribbert has shown that the tumor process resides in an isolated segment of the vessel walls and that it extends by forming its own new blood-vessels. He also showed that the vessels in the normal surrounding tissues were at the same time compressed and occluded. Judging from microscopic examination, the simple hemangioma in the former of our two cases apparently had its origin in the serosa. Many large blood-vessels with thickened walls were seen. In a number of these thrombosis had occurred. The new vessels resembled arterioles and cellular hyperplasia was present.

The cavernous hemangioma, in the second of our cases, apparently arose from the submucosa and showed the vascular channels widely dilated, with thin connective-tissue septums between them. Thrombosis of the vessels and vascular channels was seen in several places; some of the thrombi were well organized. A few of the communicating sinuses were dilated and contained blood cells. The endothelial lining of these spaces was slightly hyperplastic.

**Polyposis.**—Primarily polyposis represents a benign lesion and forms a tumor when it involves the colon. Sooner or later a very high percentage of cases of polyposis undergoes malignant change. Likewise chronic ulcerative colitis frequently is associated with polyposis and it may be a prominent etiologic factor in the production of polyposis, as Struthers has suggested. However, there still remains a group of cases in which such a complication has not supervened. It is this type of case which forms the group of thirteen cases that is included in this article. Of these patients eleven were males and two were females. The

oldest patient was a man of seventy-seven years and the youngest was a woman of twenty years; the average age was forty-four years.

The cardinal symptoms were found to be pain in the abdomen, diarrhea, passage of blood and mucus in the stools, and, occasionally, nausea, vomiting, and anorexia. Loss of weight and weakness were common complaints. Tenesmus was not very constantly found, probably because rectal lesions were not included. Of the thirteen patients, nine complained of pain and diarrhea, seven passed blood in the stool, five passed larger or smaller amounts of mucus. Pain was most often noted in the left lower portion of the abdomen because in seven of these cases the sigmoid was involved. Diarrhea varied in intensity; some patients had a mild form of diarrhea, with two to three loose stools daily; others had up to thirty watery movements in a day. In two cases a mass was felt in the right portion of the abdomen; in both, the entire colon was involved in the polyposis. In three cases the right portion of the colon was affected; in seven, the left portion. In one case the transverse colon alone was involved. Roentgenographic and proctoscopic examinations gave an accurate idea of the condition in an amazingly high percentage of cases.

Broders uses the term "polypoidosis" in preference to "multiple polyposis," and Rankin thinks it is a more descriptive term. Menetrier described a condition he called "polyadenoma en nappe" of the stomach. The term "polypoidosis" should be kept in mind, for it may come into general use. We have not employed it in this paper because, as yet, it has not been adopted by medical lexicographers.

Polyposis appears more frequently in the lower segments of the large bowel, the sigmoid, and the rectum. Most observers concur in the belief that the tendency is for this disease to develop in increasing proportions as it proceeds distally from the ileocecal coil, so that the disease is most often found in the rectum or rectosigmoid. The etiology is obscure. Perhaps there occurs, at some point in the large bowel, irritation of the mucous membrane. The cause of this irritation may be mechanical, chemical,

biochemical, metabolic, or bacterial. Some favor the theory of parasitic origin since various parasites have been found in cases of multiple polyposis. If irritation persists, an inflammation is set up which follows the reaction of a normal tissue. About the immediate focus hyperplasia of tissue occurs, whereas on either side of it healing takes place. This results in the throwing up of folds of mucous membrane, the blood supply of which is temporarily increased. These folds increase in size as the process continues; contracture may take place around them until presently they may be seen as definite rugæ jutting out into the lumen a very short distance. Then the fecal current sweeps over them as peristalsis and antiperistalsis come into play, and very slowly the rugæ become elongated, definite pedicles are pulled up from the submucosa, and a polypoid mass is formed. Struthers has suggested that an ulcerative process is most frequently the cause, and that "portions of the mucosa and submucosa adjacent to, and supplied by, primary arterial branches are preserved. It is these preserved portions that are seen studding the surface of the colon. As healing takes place, under favorable conditions, the irregular margins of these elevations are smoothed off, and remain as rounded, sessile, or polypoid projections from the mucous membrane." Whichever theory is most acceptable, it is assumed that the process is a slow metamorphosis from the stage of prominent folds of mucous membrane to that of definite polypoid formation of either pedunculated or sessile type.

The process seems to be well localized about some focus as a starting point, and in early cases only a small area of mucous membrane is involved. At either terminus of the lesion it is not uncommon to find single or multiple polypi, each usually with its own pedunculated attachment. In cases of long standing various degrees of inflammation, ulceration, superficial necrosis, and malignant change may be seen. Bleeding is common from such lesions, and the tissue is highly susceptible to slight trauma. Just as in ulcerative colitis, so in polyposis, rubbing with a cotton swab over an involved area of mucous membrane draws blood.

Some cases seem to be extremely fulminant and this is more likely to be true when the subject is a young person. The entire colon may be involved even though symptoms have been present a surprisingly short while. There is a distinct variety of the disease termed by Erdmann and Morris the adolescent or congenital form, in contradistinction to the adult or acquired type. This adolescent or congenital form is more serious than the adult type. In these respects polyposis resembles carcinoma, which devastates so rapidly in youthful persons. Most writers find young persons affected more often than adults; this has not been the experience at The Mayo Clinic. Males are more often affected than females. Newbold found that twenty-three males had the disease as compared to fourteen females, and Soper found that males predominated in the ratio of 3 to 1.

A good idea of the gross appearance of multiple polyposis is to be gained by proctoscopic examination. One sees a large or small area of involved mucous membrane which may or may not completely encircle the bowel. Upper and lower limits may be perceivable. The reduplicated folds of mucous membrane, or the polypoid masses, appear smooth and glistening; a definite mass projects into the lumen, and may be large enough to reduce the caliber of the lumen.

Sometimes a polypoid mass may be extruded from the rectum. Then, if it has a loose attachment, it may be possible to dislodge a small segment by manipulation and there may be copious bleeding or none at all. It is not uncommon to find regions of superficial necrosis, which appear as dirty gray ulcerating processes. Collections of mucus may completely cover the area. Ulceration is common. Often it is possible to tell by its gross appearance that a lesion is undergoing carcinomatous change. The amount of induration varies considerably and some notion of this can be obtained by the "feel" transmitted through the proctoscope.

Microscopically, polyposis resembles adenoma of the large intestine. The glands frequently predominate over the stroma. They are long and branched. Goblet cells may be seen in great numbers. Sometimes, where healing processes have covered

over acini and the lining cells have continued to secrete, retention cysts are observed. In addition to being larger, the glands may take more hematoxylin, and the gland cells may be hyperplastic. The cylindrical epithelium which lines the glands is often of goblet type and mucus often is secreted. The stroma is of connective tissue and in it lie the blood-vessels. In many cases the stroma forms a stalk more or less elongated. It is derived from the submucosa and its fibrous tissue; in it can be seen evidence of lymphocytic infiltration, the formation of new stroma cells, blood and lymph vessels. The stroma may be myxomatous. Exudation on the surface of the tumor is common, and tissue débris, broken-down red and white blood cells, and fragments of gland cells and fibrous strands are found.

**Cystic Tumor.**—Cystic tumors are sometimes seen in the colon and may be intrinsic or extrinsic. Cysts of the mesentery usually affect the small intestine. In our series there were two cases of cystic tumor. One of these affected largely the ascending colon. The patient was a woman aged fifty-three years, who had been ill for five years. She complained of pain in the right lower quadrant of the abdomen, which at first was intermittent, but which recently had become more constant. The pain never had been severe enough to interfere with her work. On examination, a large, tender, nodular mass could be palpated in the lower right part of the abdomen. Roentgenograms of the colon proved that the mass was extrinsic. At operation, encapsulated pseudomucinous cysts of the pelvis, of the mesentery, of the small intestine, and of the outer side of the ascending colon, where they were in greatest numbers, were found. They formed a mass in the pelvis resembling a bunch of grapes. The largest cyst was 5 cm. and the smallest 0.25 cm. in diameter. They were filled with clear fluid.

The second case is that of a man aged fifty years with a cystic tumor of the cecum. The onset of his trouble was gradual and it had extended intermittently over three years. He had had attacks of bloating, nausea, and vomiting lasting about ten hours, which had been relieved by movement of the bowels. More recently the pain had localized over McBurney's area,

which on palpation was tender. Roentgenograms of the colon were not made. At operation a tumor about 4 cm. in diameter, and containing cystic fluid, was found in the base of the cecum.

In the first case the growth probably was a serous mesenteric cyst, according to the classification of Moynihan. The second may have been a case of congenital ileocecal or mucous cyst. Such cases are rare and their etiology is obscure.

**Two Cases Not Included in the Series of Fifty-two.**—Occasionally benign tumors of the transverse colon are cured spontaneously or by medical means. We have observed two such cases.

A woman aged fifty-three years complained of constipation and passage of blood by bowel for two years. During this time she passed pieces of tissue on several occasions. The hemoglobin was 69 per cent and the erythrocytes numbered 3,920,000 in each cubic millimeter of blood. Roentgenograms of the stomach and colon did not reveal pathologic change. The mucous membrane of the bowel was normal on sigmoidoscopic examination. In the period of observation the patient passed a piece of tissue by rectum. The specimen was examined and was found to be inflammatory adenoma of the large intestine. This is the type of case often referred to in the literature; yet it is the only one of which we have a record.

A man aged thirty-nine years complained of bloating, heartburn, and constipation of six weeks' duration. Three weeks before he came to the clinic he had noticed a lump in the left side of the abdomen. Roentgenograms made elsewhere revealed a tumor of the colon. A lump could be felt in the left side, which was hard, irregular, and about 8 cm. in diameter. It was freely movable. Roentgenograms of the colon revealed a lesion of the transverse colon near the splenic flexure. The Kolmer modification of the Wassermann test on the blood was positive and the result was recorded as 44. Antisyphilitic treatment was instituted and the mass resolved. Roentgenograms of the colon one month later did not reveal a pathologic condition.

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## CASES FROM THE CLINIC OF WALTMAN WALTERS

WALTMAN WALTERS

### UTETEROLITHOTOMY AND PELVIOLITHOTOMY DONE SIMULTANEOUSLY

I WISH to present two cases in which ureterolithotomy and pelviolithotomy were done simultaneously. This procedure results in shortened convalescence and the patient's return to active duties at an earlier period; it also saves the patient the operating room expense of two operations, of a prolonged stay in the hospital, and saves him from having to take a second anesthetic.

FIG. 322.—Stones in the ureters and in the left kidney.

The first case was that of a man aged thirty-four years who presented himself with a history of urinary obstruction. There were stones in the lower portions of both ureters and a stone in the left kidney (Fig. 322). Obviously in this case at least two procedures were necessary to remove the stones, for it has been shown on several occasions that to operate on both kidneys or both ureters at once is unwise. However, by combining ureterolithotomy and pelviolithotomy in one operation he was saved the third operation. First, right ureterolithotomy was done and two and a half weeks later left

FIG. 323.—Stones in the left ureter and in the pelvis of the left kidney.

ureterolithotomy and left pelviolithotomy. The patient's reaction was no greater than would have been expected from a single operation. In the postoperative roentgenographic examination of the urinary tract, shadows of stones did not remain. The patient felt well when he returned home with the incisions healed.

The second case was that of a man aged fifty-four years on whom the operations of left ureterolithotomy and pelviolithotomy were done simultaneously with no greater reaction than would have been expected from a single operation. Three stones were removed from the lower portion of the left ureter. Then the patient was turned on his side, and a stone was removed from the pelvis of the left kidney (Fig. 323). Convalescence was uneventful.

In determining whether a one-stage or a two-stage procedure should be used, the shortened morbidity and the lessened expense to the patient should be weighed against the additional operative risk, if any. In certain groups of cases it has been shown definitely that the necessary operation is more safely performed in two stages than in one stage. For example, in cases in which the patient is deeply jaundiced from pancreatic obstruction of the common bile-duct, it has been my experience that it is of great advantage to reduce the degree of jaundice by cholecystostomy before making the anastomosis between the gallbladder and the stomach or the duodenum.

## UNUSUAL NUMBER OF LARGE STONES IN THE LOWER PORTION OF THE URETER

The patient was a Sicilian, aged fifty years. Appendectomy had been performed in 1908, and the following year three operations on the right kidney and bladder were performed elsewhere for removal of stones. The patient gave a ten-year history of attacks of right renal colic with pyuria at intervals of three to six months. At times the pain was severe, lasting from three to six days with widespread soreness over the whole right side of the abdomen, and occasionally chills and fever. Two months previous to coming to the clinic he had a similar attack accompanied by hematuria.

General examination showed two abdominal scars in the right half of the abdomen and a scar in the right renal area. A roentgenogram of the kidneys, ureters, and bladder showed seven stones in the lower portion of the ureter just above the bladder, varying in size from 0.5 to 2 cm. in diameter (Fig. 324). Two shadows approximately 2 cm. in diameter were present in the region of the right kidney. There was much pus in the urine. The blood urea was 30 mg. for each 100 c.c. Cystoscopic examination showed a slight return of indigocarmin from the right kidney, and a normal return from the left kidney. A diagnosis was made of multiple stones in a sacculated right kidney und ureter, the largest 2 cm. in diameter, and huge dilatation of the lower third of the right ureter. The right kidney was practically functionless and the left kidney was normal.

November 27 partial ureterectomy was performed, with removal of the lower two-thirds of the ureter and the stones. As a result of the previous operations on the abdomen it was very difficult to find the line of cleavage between the peritoneum and the fascia of the muscles of the bony pelvis and the ureter. The ureter could be compared with the large intestine; the diameter was 7.4 cm. It was opened and about seven stones, the largest 2 cm. and the smallest 0.5 cm. in diameter, were removed from a pocket in the lower portion of the ureter just above the bladder. The ureter was severed as close to the bladder as possible. However, there was approximately 2 cm. of it remaining attached to the bladder, and to have removed

this would have necessitated a rather serious and difficult dissection with considerable risk, so it seemed advisable to obliterate the remaining stump of the ureter with sutures. The proximal portion was dissected up to about 5 cm. from the kidney and brought out of the wound as a ureterostomy. It was decided to do a two-stage operation because of the necessity of opening up so much retroperitoneal tissue space in the removal of this huge ureter, firmly adherent as it was to the surrounding tissues.

FIG. 324.—Stones in the lower portion of the ureter.

Although the course following this operation was complicated by fever and evidence of infection, this subsided and the patient began to gain strength. December 28 it seemed safe to proceed with right subcapsular nephrectomy, with removal also of the remaining part of the ureter. Two stones about 2 cm. in diameter were in the kidney. The kidney was distended with pus.

There was very little reaction following the second operation. The course was practically afebrile until the seventh day, when fever occurred due to the accumulation of pus in two dependent pockets of the wound. These discharged spontaneously and the wound healed.

## STONES IN THE COMMON AND HEPATIC BILE-DUCTS

The most successful results following the relief of obstruction in the ducts in the biliary tract due to stones, strictures, and tumors in the head of the pancreas will occur in the cases in which stones were the cause of the obstruction. In a series of fifty cases with an obstructive lesion of the common and hepatic bile-ducts due to one or more stones in which I operated during the last four years excellent results were obtained in forty-four. The patients have been free of jaundice, pain and fever, and other evidences of biliary disease. In two other cases the results were good; the patients have been free from pain and fever but on one or two occasions have had slight transient jaundice, possibly the result of residual cholangitis. The same excellent results have occurred regardless of the size of the stones, whether single or multiple, and irrespective, too, of the degree or duration of jaundice. The important essential in the treatment of patients with stones in the common and hepatic ducts is that all stones be completely removed. In three recent cases after exploration of the common and hepatic ducts for stones with the usual common duct scoops, the increased size of the duct permitted the introduction of the little finger as a probe and a stone was felt impacted in the ampulla; in each case the stone was removed with the utmost difficulty. These patients recovered. Failure to feel these stones might have led to the erroneous conclusion of intrahepatic or pancreatic obstruction of the common bile-duct, especially in view of the slight amount of pain present in each case. There were four deaths in the series, in three of which necropsy was performed. One death was from thrombosis of the portal vein in a patient who was intensely jaundiced; the serum-bilirubin was 26 mg. and the blood urea 70 mg. prior to operation. In this case operation was performed in the hope of preventing death. Without the relief of the jaundice the case seemed to be hopeless. In two other cases in which the serum-bilirubin was 12.5 and 12 and tissues were deeply pigmented with bile, bronchopneumonia caused death. In one case death was due to peritonitis. More than three years have elapsed since

operation in thirteen of these cases; two years have elapsed in eight, more than a year in seven, and twenty-eight patients have been operated on during the last year.

### AN UNUSUALLY LARGE STONE IN THE GALLBLADDER OBSTRUCTING THE COMMON BILE-DUCT

It has been wisely said: "No one living is infallible in the diagnosis of obstructive jaundice." Whereas in most cases in which the onset of jaundice has been preceded by attacks of biliary colic without previous operation on the biliary passages the cause of the jaundice will be found to be a stone or stones in the common or hepatic ducts, yet infrequently the intermittent obstruction and colic may have resulted from the variable degree of obstruction of the pancreatic portion of the common bile-duct from chronic pancreatitis or carcinoma. If there is a history of previous operative procedures on the biliary passages the addition of incomplete strictures of the common and hepatic ducts becomes, unfortunately, only too often the cause of the obstruction. Intermittent biliary colics, chills, fever, and jaundice are the symptoms which usually indicate obstruction of the common bile-duct.

In a deeply jaundiced patient aged seventy, with a serum-bilirubin of 15 mg. the cause of biliary obstruction was an unusually large stone impacted in the gallbladder. The cystic duct had been destroyed by pressure necrosis and the stone in the gallbladder, because of its position and size, collapsed the common bile-duct. By a combination of this pressure and the inflammation and edema in the structures adjacent to the stone, including the common bile-duct, the biliary obstruction was almost complete. The appearance of jaundice with little pain and rapid loss of weight in a man aged seventy led to the belief that the obstructive lesion was malignant (Fig. 325). The intense itching, which was the chief complaint, led to the decision for abdominal exploration. Had the lesion been a malignant growth of the pancreas, relief of the jaundice and itching could have been accomplished by an anastomosis between some part of the distended biliary tract and the intestine.

The removal of the gallbladder and the gallstone was followed by an uneventful and complete recovery. The common and hepatic bile-ducts were carefully explored for stones and none was found.

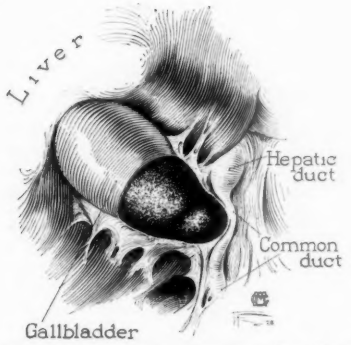


FIG. 325.—Obstructive jaundice due to compression from a large gallstone.

*History.*—July 18, 1928 a man aged seventy years was examined.
He complained of loss of strength for the last year and a half.
There was an aching pain under the right ribs which was worse on jarring.
A chill four weeks before admission had been followed by jaundice.
There was severe, intolerable itching.
He had lost 14 pounds in weight in four weeks.
*General examination.*—Jaundice was graded 3.
Serum-bilirubin was 15 mg.
Tumor in the head of the pancreas was diagnosed.
*Operation.*—July 24 cholecystectomy and exploratory choledochostomy were performed.
Chronic cholecystitis with cholelith, 10 by 8 cm., and partial necrosis of cystic duct were found.
The common bile-duct was normal in size and did not contain stones.
*Postoperative course.*—The patient was dismissed from hospital on the eighteenth postoperative day.
The wound was healed and the general condition was excellent. August 17 the patient was dismissed from observation.

It should be borne in mind that no matter how great the evidence of a malignant growth as the cause of biliary obstruction, stones and a benign lesion in the biliary tract may often be the cause of painless biliary obstruction. The corollary of this is that abdominal exploration should be considered in all cases

of obstructive jaundice in which the general condition would seem to permit exploration at a reasonable risk.

### STRICTURES OF THE COMMON AND HEPATIC DUCTS

The success of operation with permanently good results in cases of stricture of the common and hepatic bile-ducts depends on there being sufficient normal duct remaining above the stricture to permit an exact anastomosis between the mucous membrane of the duct and the duodenum as first successfully performed and described by W. J. Mayo in 1905. I have been able to use this method of direct anastomosis to relieve the stricture of the common bile-duct in seven cases. The results were excellent and the patients have been free from any evidence of obstruction or biliary disease with the single exception of a young woman who suffered from severe cholangitis several months after complete recovery from lateral choledochoduodenostomy. After several weeks of illness from cholangitis the liver and spleen were enlarged and abdominal ascites was present. The ascites was relieved by the use of one of the mercurial diuretics.

Another patient of this group was operated on in May, 1926, at which time the serum-bilirubin was 17.4 mg. for each 100 c.c. of blood. A duodenal fistula developed during the first few days following operation. The accompanying toxemia was controlled by intravenous injections of physiologic sodium chlorid solution and the fistulous tract was kept dry by the suction pump. Further disturbance of the biliary tract did not occur. This case was reported in detail in the Surgical Clinics of North America in 1926; it is of interest to know that the patient continues to be in excellent health without any evidence of biliary tract obstruction or infection. The date of the last letter from this patient was April, 1929.

Occasionally one finds that stricture involves the entire length of the common and hepatic ducts so that there is not a sufficient amount of duct remaining below the level of the liver to permit anastomosis with the duodenum. Such cases furnish a difficult surgical problem. Recent reports, however, of successful transplantation of external fistulous tracts into the

duodenum or stomach by Lahey, Masson, Lilienthal, St. John, and Walters, following the first successful case reported by Williams in 1914, have served as an impetus to the use of the method when complete stricture of the extrahepatic biliary ducts exists. In general, the scheme is to establish an external biliary fistula, and after it has persisted long enough to become established (usually from two to four months) the tract is coned out and transplanted into the duodenum or stomach. The ease with which such a coned-out fistulous tract can be transplanted into the duodenum is surprising. An illustrative case follows:

*History.*—November 30, 1927 a woman aged forty-one years was examined.
Cholecystectomy had been performed elsewhere the previous February.
Bile drained for eight weeks following the operation.
The patient had had pruritus six months later and had lost 30 pounds in weight.
*General examination.*—Jaundice was graded 3.
Serum bilirubin was 15 mg.
Secondary anemia was present.
Stricture of the common bile-duct was diagnosed.
*First operation.*—December 8 external drainage of the intrahepatic ducts was carried out.
Stricture of the entire common duct and hepatic ducts to the liver were found.
*Postoperative course.*—January 11, 1928 the patient was dismissed. February 9 she returned.
The serum-bilirubin was less than 0.3 mg.
An external biliary fistula was present.
*Second operation.*—March 13 transplantation of the biliary fistula into the duodenum was performed.
*Postoperative course.*—March 18 to 25 the wound healed and the stools were normal.
March 26 bile drained from the wound.
April 21 the wound was healed.
May 21 a letter from the patient stated that she was feeling well and that the wound had healed.
The stools were reported normal.
In September, 1928 the patient reported her condition excellent, without evidence of biliary disease or obstruction.
A similar report was received in May, 1929.

A carcinoma or inflammatory tumor in the head of the pancreas may compress the common bile-duct sufficiently to produce progressively increasing jaundice. In most of these

cases the jaundice is accompanied by uncontrollable itching which is so constantly intense that the patient is glad to go to any end to be relieved. Moynihan has said that he believes the incidence of suicide in such cases because of the itching is as great as the deaths from operation.

Anastomosis between the distended portion of the biliary tract, usually the gallbladder, and the stomach or duodenum produces a short circuit of bile into the intestinal tract with relief of jaundice. If the obstruction is benign or inflammatory, permanently beneficial results are obtained; if due to pancreatic carcinoma, the jaundice and itching are relieved. In such carcinomatous obstructions, although the patient eventually succumbs to the effects of the malignancy, yet he is able to enjoy many months of comfortable existence in the interim from the relief of the jaundice. If a tumor is found at the head of the pancreas, the surgeon usually is unable to distinguish between an inflammatory and a malignant lesion. To remove a piece of the pancreas for microscopic diagnosis may satisfy curiosity, but it is accompanied with the danger of producing almost uncontrollable bleeding or leakage of pancreatic secretion into the abdomen.

The beneficial results obtained from an anastomosis between the distended biliary tract and the intestine in cases of pancreatic obstruction of the common bile-duct are often startling and prolonged. In a group of twelve such cases seven patients are living and well, free of jaundice and itching. One of them has lived more than two years since the operation. Recent examination, and information received in letters from him, show that his general condition is apparently satisfactory. Another patient in the series lived comfortably for nineteen months, and another lived for ten months. One of the patients died on the seventh day subsequent to the operation with a clinical syndrome which was believed to be a combination of hepatic and renal insufficiency characterized by stupor and then coma, decrease in urinary output, and retention of 200 mg. of urea in the blood. Necropsy did not reveal anything to explain the cause of death other than slight localized peritonitis.

The anastomosis between the distended biliary tract and the intestine should be made as large as possible in order to obtain complete and immediate relief of the biliary obstruction, so that not even temporary or incomplete obstruction is possible from edema and swelling about a small anastomosis (Fig. 326).

FIG. 326.—Choledochoduodenostomy for relief of pancreatic obstruction.

*History.*—December 30, 1927 a man aged sixty years came to the clinic.
He reported pain in the right upper quadrant.
Slight jaundice.
Clay-colored stools.
Painless jaundice with dark urine and light stools began in October.
He had lost 20 pounds in weight.
Cholecystostomy had been performed in 1924 (elsewhere).
The gallbladder was ruptured and contained stones.

*General examination.*—Jaundice was graded 4.
Serum-bilirubin was 11.5 mg.
Hemoglobin was 45 per cent.
Erythrocytes numbered 3,000,000.
Stone in the common duct and tumor at the head of the pancreas were diagnosed.

*Operation.*—January 19, 1928 a tumor at the head of the pancreas was found and choledochoduodenostomy was performed.

*Postoperative course.*—February 4 the patient was dismissed in excellent general condition.
March 27 the patient had gained 30 pounds in weight.
There was no jaundice.
The patient felt fine and was eating everything.
The wound was perfectly healed.

# PARTIAL NASAL RECONSTRUCTION

FREDERICK A. FIGI

THE loss of a portion of the nose, whether accidental or due directly or indirectly to disease, is of serious moment on account of its effect on the individual's social and economic status. Artificial restoration is, as a rule, unsatisfactory; unless especially well done it tends to exaggerate the defect rather than to render it less conspicuous, and thus the patient is often more keenly conscious of his deformity. Reconstruction of the lost parts with the patient's own tissues is the most satisfactory method. The objective, then, is to secure sufficient tissue to rebuild most satisfactorily the deformed organ with the production of the least amount of visible scarring.

The objection which at times is raised to the use of facial flaps in nasal reconstruction, especially in women, because of the scarring they produce, must be given consideration. Yet the color and texture of such flaps are vastly superior to those taken from some distant portion of the body, they can be obtained with comparative ease, the economic factor is important in view of the fact that the procedure is economical of time, and with the use of facial flaps it is unnecessary to subject the patient to the torture of maintaining the awkward position necessary for the transfer to the face of tissues from the arm, chest, or abdomen. These considerations easily influence one in favor of the employment of facial flaps.

The group of cases reported here shows the possibility of adequate restoration of partial nasal losses and demonstrates the value of facial flaps in this regard.

## REPORT OF CASES

**Case I.**—A woman aged fifty years came to The Mayo Clinic September 2, 1925, because of an extensive epithelioma covering most of the external

nose, more on the right side than on the left. This had developed in a scar which followed repeated roentgen-ray treatment, given ten years previously for probable lupus, and had been present for about a year. It measured 2.5 by 3.5 cm. and appeared to be fixed to the cartilage. Lymphatic enlargement was not present. September 8, 1925 the lesion was excised with the cutting cautery. Microscopically it proved to be a squamous-cell epithelioma, graded 1. Invasion of the underlying cartilage had not taken place and the growth stripped off cleanly.

Slightly more than two years later the patient returned for reconstruction of the lost portions of the nose, since the lesion had not recurred. The nasal deformity present at that time is shown in Figure 327. A flap from the frontal region was elevated, under local anesthesia, October 11, 1927. Be-

FIG. 327.—(Case I.) Postoperative scarring with loss of portion of both alæ of the nose.

FIG. 328.—(Case I.) Reconstruction with flap from the forehead. The scarring on the right cheek followed treatment of lupus.

cause of extreme thinness of the skin and the lack of subcutaneous tissue it was deemed advisable to elevate the entire flap and suture it back in its original position twice before transferring it to the nose. It was brought down October 25, 1927, and the distal portion of the denuded area on the forehead was covered with a full thickness skin graft from the arm at the same time. The proximal portion of the denuded area was later covered by the returned pedicle. A lining for the lost portion of either ala was supplied by doubling under the distal end of the flap. The result is shown in Figure 328. The thinness of the patient's skin rendered this very satisfactory. Later a scar

on the right cheek resulting from carbon dioxid treatment to an area of lupus was excised and a full-thickness skin graft applied.

**Case II.**—A girl aged eighteen years came to the clinic July 8, 1925, because of an external nasal deformity of several years' duration. It consisted in a saddle-back depression and foreshortening of the entire nose with drawing up of the tip. The columella, the entire cartilaginous septum, and most of the bony septum were missing. The patient stated that five years previously marked soreness had developed in the roof of the mouth. This gradually extended into the nose, where it became more acute, and after about a year the nasal septum and columella were gradually lost in the progressive ulceration and sloughing which followed. She was then given active antisyphilitic treatment for two years and the ulceration healed. The Wasser-

FIG. 329.—(Case II.) Loss of columella and most of the nasal septum.

FIG. 330.—(Case II.) Foreshortening of nose and saddle-back deformity.

mann reaction was positive at the time of examination in the clinic and congenital syphilis was diagnosed. Figures 329 and 330 show the patient's appearance at the time of admission.

Following a course of antisyphilitic treatment reconstruction of the columella was undertaken. A flap of skin and subcutaneous tissue about 6 mm. in width extending along the median line of the upper lip from the nasal vestibule to the mucocutaneous border was elevated, leaving an attachment at either end. A full-thickness skin graft from the inner surface of the arm was inserted beneath this in order to form a flap covered on all sides with epidermis. The flap was sutured back in its original position, the sutures closing the wound transfixing the graft in order to insure its remaining in

position. After about ten days the lower end was cut across, brought up, and sutured in place just inside the tip of the nose. The margins of the wound in the upper lip were undercut and carefully approximated with dermal sutures. About two years later the patient returned for further consideration and a costal cartilage implant was inserted to correct the saddle-back depression. These operative procedures were carried out entirely under local anesthesia. The end-result is shown in Figures 331 and 332.

FIG. 331.—(Case II.) Reconstruction of columella with a flap from the upper lip.

FIG. 332.—(Case II.) Correction of the saddle-back deformity with a costal cartilage implant.

**Case III.**—A girl aged sixteen years came to the clinic June 3, 1927 on account of an external nasal deformity. At birth the patient had an angioma of the tip of the nose. Repeated treatments with carbon dioxid snow produced little change and at the age of two years some form of electrical treatment, probably roentgen-ray treatment, was given. Following this the tip of the nose sloughed with the presenting deformity (Figs. 333, 334). The patient's general health was excellent. Examination showed loss of the tip, together with the anterior portion of the left ala and the columella of the nose. General examination was negative.

Reconstruction of the lost portion of the nose with a Blair type of flap from the forehead was carried out in stages, under local anesthesia; the flap was sutured back in its original position immediately following elevation and transfer of its distal end to the nose was delayed for about two weeks. Epidermis for either side of the columella and a lining for the anterior portion of the left ala was obtained by doubling under the distal part of the flap as described by Blair.

FIG. 333.—(Case III.) Loss of the lower portion of the nose following treatment of angioma.

FIG. 334.—(Case III.) Profile before reconstruction.

FIG. 335.—(Case III.) Reconstruction of the tip of the nose with a flap from the forehead.

FIG. 336.—(Case III.) Profile after reconstruction.

At the time the flap from the forehead was first elevated a full-thickness skin graft from the inner aspect of the left upper arm was inserted beneath the distal portion of the flap, in the upper part of the wound on the forehead, and was sutured in place with its epidermal surface outward. This graft filled the defect normally covered by the portion of the flap to be utilized in the reconstruction, and its application at this time shortened the second stage operation correspondingly. The scarring on the forehead in this instance was effectively concealed by dressing the hair in the manner illustrated. The result is shown in Figures 335 and 336.

# CASES FROM THE SECTION ON ORTHOPEDIC SURGERY

HUGH T. JONES

## OSTEOMYELITIS OF FEMUR. SEQUESTRECTOMY THROUGH SPECIAL TYPE OF INCISION

**Case I.**—A young man aged nineteen years came to the clinic complaining of a discharging sinus of the right thigh. Two years previously he

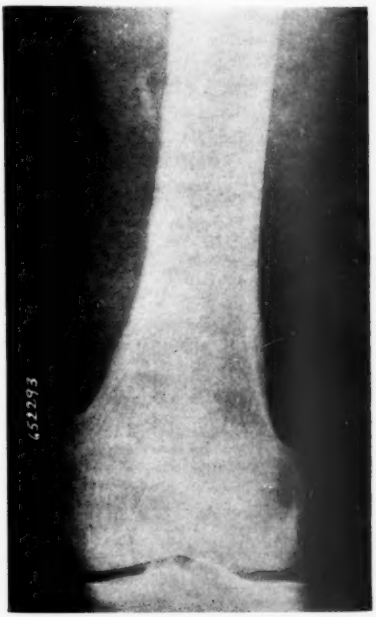


FIG. 337.—Roentgenogram of the lower part of the right femur showing evidence of a sequestrum medial to the shaft (Case I).

had "wrenched" his left leg, and later an inflammatory process started above the knee. About six months previously a hot, red, painful swelling appeared

above the knee on the inner side of the thigh. This ruptured and discharged pus. Pus had been discharged practically ever since.

Examination revealed a sinus on the medial aspect of the right lower thigh. The range of motion in the left knee was 180 to 140 degrees. Roentgenograms of the left femur showed evidence of a sequestrum medial to the middle third of the femur about 15 cm. proximal to the sinus (Fig. 337). Exploration was advised.

July 3 the sinus was injected with methylene blue solution. The sinus was found to lead proximally toward the sequestrum. Through a vertical incision which exposed the medial surface of the lower third of the thigh, the

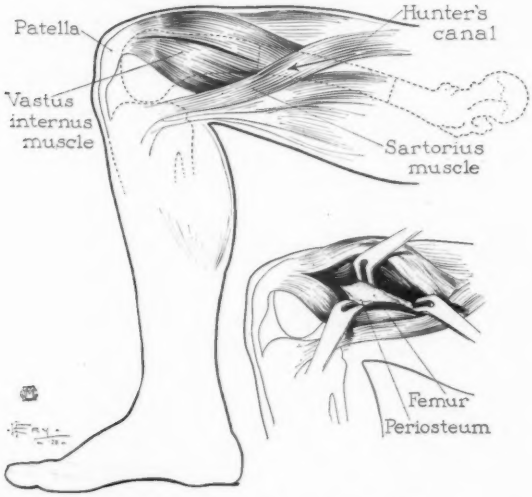


FIG. 338.—Exposure of the lower third of the femur by a muscle-splitting operation of the vastus internus. This fistulous tract was excised through this approach and a sequestrum removed. Care was used not to open the knee-joint nor to injure the vessels in Hunter's canal (Case I).

lower third of the femur was exposed by dividing the fibers of the vastus internus (Fig. 338). By this exposure the sinus tract could be followed proximally up under Hunter's canal. A probe inserted into the sinus located the sequestrum where it lay under the femoral vessels. The fragment of dead bone could be extracted with a pair of curved forceps. As much as possible of the fistulous tract was excised, and the portion extending under Hunter's canal was curetted. The wound was closed except for a vaselin gauze pack protruding from the proximal end of the incision. July 25 the patient was dismissed with the wound draining slightly.

A letter from the patient, dated November 7, stated: "My leg healed nicely and it is still a little stiff. I can bend it back more than right angles, and I think it is slowly loosening up. I can get around very well and it does not bother me much."

I wish to call attention to this muscle-splitting incision through which the medial aspect of the lower third of the femur may be exposed without cutting across the vastus internus. The only danger point is Hunter's canal at the proximal end of the incision. Care must be exercised, especially in cases in which infection is present, not to open the knee-joint at the distal end of the incision.

## REPAIR OF RUPTURE OF TRIANGULAR FIBROCARTILAGE OF WRIST

**Case II.**—The patient was a miner aged thirty-five years who came to the clinic June 11, 1928, complaining of pain in the left wrist with weakness. In June, 1927 he had sustained a fracture of both bones of the left forearm. The ulna had united readily and union in the radius had followed an open operation, at which time the fragments of the radius had been wired together. Marked limitation of supination had resulted. Judging from the patient's story, the hand had been forced into supination by manipulation. Following this, slipping was noted in the wrist in which the distal end of the ulna became unduly prominent on the dorsum of the wrist, and the radius carrying the carpus and hand slipped forward. A diagnosis was made of rupture of the triangular fibrocartilage of the distal radio-ulnar joint. The roentgenogram (Fig. 339) indicated united fracture of the radius and ulna with shortening of the radius which caused the ulna to be relatively too long. Two measures were thought advisable: shortening of the ulna and repair of the ruptured triangular fibrocartilage.

At operation the ulna was shortened about 1.5 cm. by a stepping operation in the distal third, as indicated in the postoperative roentgenogram (Fig. 340). When the distal radio-ulnar joint was exposed it was evident that the recurring dislocations were due to a defect in the attachment of the triangular fibrocartilage to the styloid process of the ulna. By means of two stitches of chromic catgut the fibrocartilage was sewed to the tissue in the region of the base of the ulnar styloid. It was immediately apparent that these stitches prevented the abnormal mobility of the carpus and radius on the distal end of the ulna, but still permitted pronation and supination. After closure of the wounds a cast was applied with the hand at the limit of supination, which was just past the midposition. The cast was removed about a month after operation and the stitches were removed from the wound which had healed by first intention. Local heat, massage, and exercises for the forearm, wrist, and hand were then initiated by using half of the cast as

a splint before treatments for about two weeks. Early appearances indicated an excellent result, and a letter from the patient dated October 7 stated, "My wrist is nearly as strong as ever."

A clear idea of the structure and function of this triangular fibrocartilage is necessary for an appreciation of the disability

FIG. 339.—Old fracture of the radius and ulna in a case of rupture of the triangular fibrocartilage in the wrist. It may be noted that the ulna is too long as compared with the radius (Case II).

FIG. 340.—Postoperative roentgenogram indicating shortening of the ulna by stepping operation. The ruptured triangular cartilage had also been repaired (Case II).

resulting from its rupture. Figure 341 indicates how this cartilage stretches from the distal end of the radius to the ulnar styloid. By its triangular shape, the base of the triangle being attached to the radius and the apex of the triangle being attached to the

ulnar styloid in an eccentric manner, this structure provides great stability, but still allows pronation and supination.

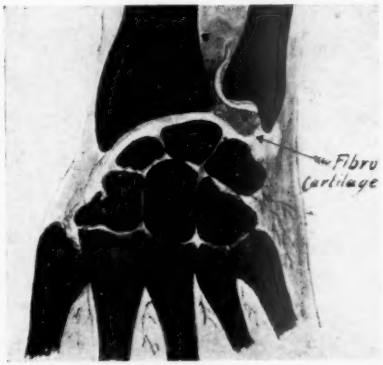


FIG. 341.—Drawing from Lasher* illustrates the anatomy of the triangular fibrocartilage of the distal radio-ulnar joint. It connects the radius to the ulnar styloid, but permits pronation and supination (Case II).

The shortening of the ulna was necessary in order to bring its distal end into proper relationship with the radius so that the repaired fibrocartilage might function.

### ANEMIC ULCER OF LEG TREATED BY PEDICLE GRAFT

**Case III.**—The patient, a housewife aged forty years, came to the clinic October 4, 1927 because of an ulcer just proximal to the left internal malleolus. Following an attack of quinsy fifteen years previously, what was evidently phlebitis of the left leg developed. A year later an ulcer appeared on the inner side of the ankle. Since then the ulcer had alternately healed and opened. In January, 1927 an attempt had been made elsewhere to bring down a pedicle graft from the upper part of the same leg, but part of the flap had become gangrenous and the plan was abandoned. The ulcer had drained continuously for two months before registration.

Examination revealed the presence of an ulcer measuring 3 by 2 cm. in the region of the left internal malleolus (Fig. 342). An area of induration extended 1.5 cm. around the ulcer. The great saphenous vein was rather tortuous and a number of the veins of the leg were moderately enlarged.

The patient was placed in bed with the foot elevated, and warm moist dressings were applied. October 18 the clean granulating ulcer was covered

* Lasher, W. W.: Cartilage injuries. A clinical study. Jour. Bone and Joint Surg., 1928, x, 587–593.

by two Thiersch skin grafts. Complete healing resulted and, November 2, the region of the old ulcer was excised deeply together with the nearby scarred skin and subcutaneous tissues. A pedicle flap was cut from the posterior

FIG. 342.—Anemic ulcer of the leg secondary to old thrombophlebitis and varicose veins. Treatment by deep excision of ulcer and pedicle transplant from opposite calf (Case III).

aspect of the opposite calf in such a way that the wound on the inner surface of the left ankle could be covered (Fig. 343). The bare area on the posterior

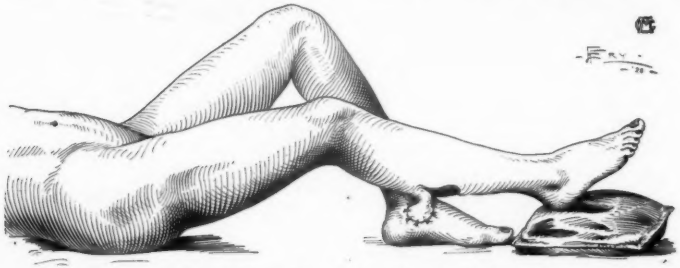

FIG. 343.—Pedicle graft from the right calf to the left ankle (Case III).

aspect of the right calf was covered by a full-thickness skin graft which was removed from the right thigh. Plaster-of-Paris casts were applied over the dressings extending from the toes to the groin on each side in such a way

that the legs were held in the proper attitude without tension on the pedicle of the transplanted flap. November 12 the pedicle was partly severed and November 16 it was completely severed. The transplant healed perfectly except for a small area which closed over without trouble. The full-thickness skin graft on the posterior aspect of the right calf did not take completely, but healing ensued without trouble. January 7, 1928 the left great saphenous was ligated in four places above the knee. The enlarged veins below the knee were ligated through several transverse cuts. Figure 344 shows the condition of the leg November 3, 1928. The ulcer had remained healed.

An important measure in bringing about healing of an anemic ulcer of the leg is the deep excision of scar tissue to get rid of avascular tissue of low vitality and to reach the deep lymphatic

FIG. 344.—Healing of anemic ulcer. Condition eleven months after operation (Case III).

supply and blood supply. In a case in which nutrition of the leg is embarrassed not only by varicose veins but by the effect of old thrombophlebitis, a graft of this type will stand the test of time better, I believe, than the thin skin grafts. Operations on the vein following thrombophlebitis are likely to result in more trouble unless the deep veins are open. The ability to wear an elastic bandage with comfort may be taken as evidence that the deep veins of the leg are open.

## REPLACEMENT OF SCAR OVER THE TIBIA AND THE OS CALCIS BY TUBE PEDICLE TRANSPLANT FROM ABDOMEN

**Case IV.**—A man aged twenty-eight years came for examination because of scarring over the left lower shin and over the left heel. In 1918 he had sustained a compound fracture of the left tibia and fibula. Union with great overgrowth of bone had been obtained, but the scarred adherent skin covering the tibia became painful when it was bumped. There was a troublesome tender scar over the left heel that had resulted from a pressure sore. The patient wished to have these areas replaced by good skin, even if considerable time and trouble were required.

FIG. 345.—Adherent scar on the shin and heel following compound fracture of the left tibia and fibula (Case IV).

Sufficient skin was not readily available nearby, so a tube pedicle graft from the abdomen was planned. September 21, 1927 a flap was raised from the abdomen (Fig. 345). By two parallel incisions an area of skin and subcutaneous fat 22.5 cm. long and 10 cm. broad was raised, leaving an attachment at each end. The long edges of the raised portion of abdominal wall were sutured together to resemble a suitcase handle. The edges of the skin beneath this tube were approximated (Fig. 346, *a*).

The wounds healed without trouble except for an area of granulation under each end of the tube. November 2 several small Thiersch skin grafts were placed on these granulations and healing ensued. November 15 the right end of the tube was detached from the abdomen and sewed into the inner side of the right thigh (Fig. 346, *b*). December 5 the scar tissue on the front of the left shin was excised. The left end of the tube was detached from the abdomen. By flexing the left knee it was possible to cover the bare area on the left shin with a portion of the tube which had been split

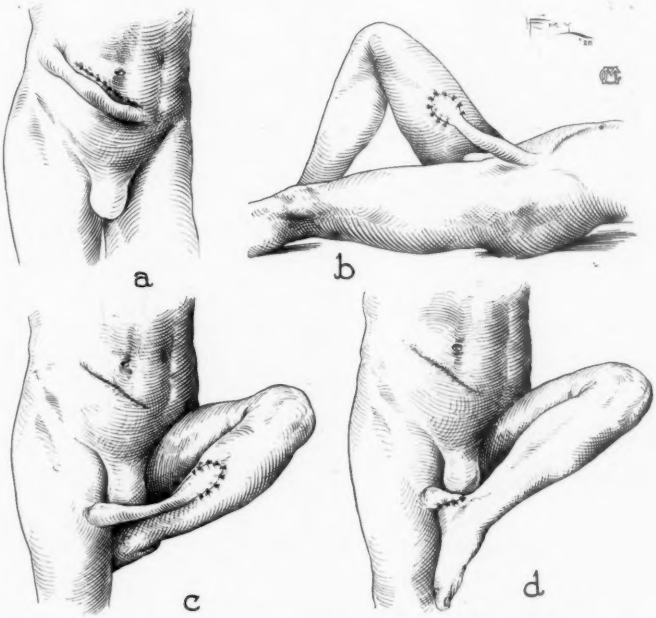


FIG. 346.—*a*, Tube pedicle raised from abdomen resembling suitcase handle; *b*, transplant of the right end of the tube into the right thigh; *c*, covering of the defect on the shin by flattened portion of the tube; *d*, covering of the defect on the heel by remainder of the tube (Case IV).

to obtain a flat portion (Fig. 346, *c*). The necessary position of the legs in relation to each other was maintained by plaster casts. The transferred skin and fat healed into place satisfactorily and, December 28, it was detached from the tube pedicle and the final suturing of the transplant to the left shin was done. This left a portion of the tube still attached by one end to the inner side of the right thigh. After excising the scar tissue on the left heel, the free end of the remaining tube was flattened and sewed into place to fill

the defect on the heel (Fig. 346, *d*). January 18, 1928 this portion was cut loose from the pedicle. Final trimming and suturing of the transplant into

FIG. 347.—Replacement of adherent scar on the shin by skin and subcutaneous tissues from the abdominal wall (Case IV).

FIG. 348.—Defect on the left heel replaced by tube pedicle graft from the abdomen (Case IV).

place was delayed until January 25. The transplant satisfactorily covered the area on the heel as well as on the shin (Figs. 347, 348).

The tube pedicle graft from the abdomen, when moved by stages, affords skin and subcutaneous fat for a distant part of the body. Scars over the shin and heel often cause considerable trouble.

## BURN CONTRACTURE OF RIGHT HAND TREATED BY FULL-THICKNESS SKIN GRAFTS

**Case V.**—The patient was a child aged three years and nine months. In October, 1926 he had fallen into the ashes of a bonfire, burning the right hand. Healing ensued in one month, but was followed by the gradual appearance of contractures. The thumb was least contracted and the fifth finger most contracted (Fig. 349).

October 6 the contracted skin and scar tissues on the palmar surfaces of the four fingers of the right hand were excised. Patterns of the defects in the skin were made carefully and full-thickness skin grafts, devoid of fat, were cut from the lateral surface of the right thigh. The grafts were carefully sewed into place on the fingers after all hemorrhage had been stopped. Mul-

FIG. 349.—Burn contracture of right hand (Case V).

tiple interrupted sutures were used to secure accurate contact of the skin edges. The grafts were covered with a copious dressing of fluffed gauze and over this was a plaster-of-Paris dressing extending from the finger tips to the axilla, holding the fingers extended fully and spread. The elbow was bent to prevent the cast from slipping.

October 23 the dressings were removed; the grafts had taken entirely. A posterior splint was applied to maintain finger extension and spread. A dressing was applied under moderate pressure. October 25 baking, massage, and exercises were instituted, and directions were given for wearing the splint only at night. October 30, the patient was dismissed with the grafts healed and with practically full motion in the hand (Fig. 350).

The case suggests some of the advantages of the full-thickness skin transplant. The annoyance of a pedicle graft is avoided; this is especially important if the patient is a child. Flexible skin is obtained by such a graft and a minimum of contracture follows. A number of prerequisites are necessary for success in such a graft: (1) A free excision of the scar; (2) an aseptic field; (3) the cutting of the graft by pattern so that it will fit perfectly;

(4) the use of wide strips of skin, as a narrow strip grafted on the palmar surface of a finger will more likely contract; (5) the cutting of the graft away from the fat; (6) the use of interrupted sutures in order to obtain close approximation of skin edges; (7) the moderate resilient pressure on the graft afforded by fluffed

FIG. 350.—Excision of scar and full-thickness skin grafts. Appearance twenty-four days after operation. The skin grafts have been outlined in black (Case V).

gauze; (8) the use of splints and plaster-of-Paris to maintain moderate pressure to provide rest to the part and to hold the correction of the deformity; (9) the avoidance of inspecting the graft until the fourteenth day, and (10) the maintenance of pressure on the graft until about three weeks after the operation.

# DATA CONCERNING THE USE OF VARIOUS ANESTHETICS IN THE MAYO CLINIC IN 1928, WITH SPECIAL REFERENCE TO SPINAL ANESTHESIA, ACETYLENE, AND CARBON DIOXID

JOHN S. LUNDY

THIS is the fourth of a series of articles dealing with the varying popularity of anesthetic agents as they are used in The Mayo Clinic each year. Reports for 1925,[2] 1926,[4] and 1927[5] have appeared elsewhere. The data presented in Tables 1 and 2 will be discussed briefly. The same plan has been followed in the arrangement of data in this article as was used in the article for 1927.

It may be noted that the data in Table 1 are arranged from a slightly different standpoint than those in Table 2. In Table 1 the varying percentages for any given year total 100, and the percentages in Table 2 total more than 100, for the reason that in some cases several agents, such as ether, ethylene, carbon dioxid, and nitrous oxid have been used during an operation; a single case in Table 2, therefore, must be included under several headings.

TABLE 1

ALL AGENTS USED (EACH FIGURE IN THE TABLE IS COMPUTED FROM THE NUMBER OF INDIVIDUAL CASES FOR THE YEAR COMPARED WITH THE TOTAL NUMBER OF CASES FOR THE YEAR)

| Agent. | 1928. Per cent. | 1927. Per cent. |
|---|---|---|
| Local* | 40.39 | 40.2 |
| Local and ether | 0.26 | 0.3 |
| Local and gases† | 9.96 | 11.6 |
| Spinal‡ | 1.21 | 0.4 |
| Ether (semi-open drop method) | 16.75 | 19.6 |
| Gases† | 30.13 | 26.9 |
| Ethyl chlorid† | 0.73 | 0.3 |
| Oil-ether colonic | 0.58 | 0.6 |
| Chloroform | ..... | 0.03 |

* Includes the local anesthetic used for extraction of teeth, thyroidectomy, tonsillectomy, hemorrhoidectomy, and so forth.

† With or without ether. ‡ With or without general anesthesia.

TABLE 2

AGENTS OF SPECIAL INTEREST (PERCENTAGE OF CASES IN WHICH CERTAIN ANESTHETIC AGENTS WERE USED, BOTH ALONE AND IN COMBINATION WITH OTHER AGENTS)

| Agent. | 1928. Per cent. | 1927. Per cent. |
|---|---|---|
| Local | 51.8 | 52.2 |
| Ether | 44.6 | 45.9 |
| Ethylene | 30.9 | 33.5 |
| Nitrous oxid | 27.9 | 18.9 |
| Carbon dioxid* | 32.5 | 25.0 |
| Acetylene | 0.06 | |

* Used as a respiratory stimulant only.

## LOCAL ANESTHESIA

As shown in Table 2, local anesthesia was used in about the same number of cases in 1928 as in 1927. There has been little change in the extent to which this type of anesthesia has been used in the clinic for the last four years. As has been pointed out,[5] spinal anesthesia was reintroduced July, 1927. It was applied about three times as often in 1928 as in 1927, but it was used during the twelve months of 1928 as compared with six months of 1927. In 1928 it was used by several surgeons, whereas in 1927 it was used by two or three surgeons only. During 1927 spinal anesthesia was used principally for preparing patients for operation for malignant lesions of the large bowel. Its use in 1928 was extended in occasional cases to other operations. Throughout this whole series ephedrin has been used, and the results seem to show that ephedrin should be given fifteen to twenty minutes before the subdural injection of procain except in cases of hypertension. Three-fourths of a grain of ephedrin is sufficient in the majority of instances. It is not more desirable to elevate blood pressure markedly during spinal anesthesia than to drop it to a low point, so that in some cases ¾ grain of ephedrin may be more than enough to offset the lowering effect of procain on the blood pressure.

With the close of 1928 it seemed that the severity of the untoward reaction which had been observed previously in spinal anesthesia had decreased, as had the frequency of such reactions, so that the problem which gives the most concern now is

that of increasing the period of anesthesia and of retaining safety. Certain investigations would seem to indicate that the use of oxygen may be advantageous in untoward reactions. I am much impressed with the results of the use of oxygen and of pulmonary ventilation on animals in the laboratory under complete spinal anesthesia, and during 1928 I occasionally administered oxygen to patients who were anoxemic under spinal anesthesia. In most instances these patients seemed to be benefited by the administration of oxygen. I feel it worth while to repeat a statement made previously[5]: "If anoxemia is avoided, death under spinal anesthesia may be prevented," at least in the laboratory animal.

Laboratory experiments carried on in regard to the use of iso-amylethyl barbituric acid (amytal) have convinced me that the principal benefit of using amytal preoperatively, before procain is injected, to reduce untoward reaction, is that the amytal seems to quiet the brain centers so that they are less stimulated by the procain floating in the blood stream than when amytal is not used. I have reported previously[3] a case in which a patient, while being prepared for hemorrhoidectomy, went into a convulsion after the injection of the first 3 c.c. of 1 per cent solution of procain into the sacral hiatus. There is no doubt in my mind that it was an intravenous injection. The patient recovered quickly from the untoward effect of the procain, and the sacral block was then completed without any further difficulty. Cyanosis was one of the alarming symptoms presented by this patient while in convulsion, and the difficulty of providing adequate artificial respiration with the patient in a convulsion is obvious. In the laboratory we were able to show that animals that had had even a small dose of amytal intravenously did not have convulsions. The use of amytal as preliminary medication was begun for patients who were to have hemorrhoidectomy under sacral block. Varying amounts of amytal[1] were tried, with and without morphin, but since amytal in small doses is hypnotic and not analgesic, it was thought best to use a small dose of morphin to lessen the pain of the needle punctures in the skin. At Dr. Isenberger's suggestion

chloretone was added, and since July, 1927 this preliminary medication has been given a sufficient number of times to make the results significant. Ten grains of chloretone (capsule by mouth) are given at bedtime the night before operation, 10 grains again at 9 o'clock in the morning, 4½ grains amytal by mouth at 9.30 in the morning, ⅛ grain of morphin at 10 o'clock hypodermically, and sacral block induced at 10.15 if the operation is to start at 10.30.

I believe that this preliminary medication is better than either ⅙ or ¼ grain of morphin for patients requiring this particular operation. I have not seen untoward results from it thus far, and the surgeon and patient, as well as I, have little if any complaint to make. Although the results are not perfect, the method is an improvement over previous methods.

### COMBINED ANESTHESIA

Combined anesthesia was used less often in 1928 than in 1927, but it was used more often in 1928 than any of the previous years except 1926 and 1927. I have no doubt that combined anesthesia is as safe, if not more so, than any other form in use at the present time. During 1928 it was used principally in operations on the thyroid gland, and by one surgeon in all operations for duodenal or gastric ulcer.

### ETHER (BY THE SEMI-OPEN DROP METHOD)

The extent to which ether was used by the semi-open drop method was about the same in 1928 as in 1927. Table 1 shows that its use by the semi-open drop method was less in 1928 than in 1927, but in any and all cases, as indicated in Table 2, it was used with as great relative frequency, except that it is now more often administered through a gas machine than heretofore. Further analyses of the data in regard to ether showed that all anesthesia by means of ether was induced in one of three different ways: the ether was administered in 0.5 per cent by the oil-ether colonic method, in 16.7 per cent by the semi-open drop method, and in 27.3 per cent by means of a gas machine, either through a mask or through an intratracheal catheter. I believe

that the use of small amounts of ether to reinforce either ethylene or nitrous oxid does less harm than the anoxemia that may be produced if one attempts to avoid the use of ether.

### CHLOROFORM

Chloroform was not used in 1928; it has not been used since early in the autumn of 1927. I do not expect it to be reintroduced for some time, or unless some unexpected development occurs in its use.

### ETHYL CHLORID

It will be noted in Table 1 that ethyl chlorid was used about twice as often in 1928 as in 1927, principally, of course, for rapid induction, to be followed by ether. In some instances the ether was given by the colonic route, and sometimes it was insufflated through an intratracheal catheter. When given intratracheally it was sometimes given with ethylene and oxygen and sometimes with nitrous oxid and oxygen.

Ethyl chlorid affords quick control of a patient whenever anesthesia becomes light, since it induces anesthesia rapidly. Ethyl chlorid is not unpleasant and for this reason is still more suitable, particularly since it is not the plan to produce deep or prolonged anesthesia with it.

### OIL-ETHER COLONIC ANESTHESIA

Oil-ether colonic anesthesia was used in about the same number of cases in 1928 as in 1927, although it was used for only about the first seven months of the year as compared with twelve months in 1927. Serious untoward results with colonic anesthesia in 1928 have discouraged several surgeons in the use of the method, and although I believe it is about as free from untoward results as most methods of anesthesia, I realize that it has had a set-back from which it will not recover for a long time. The method has been condemned when the fault probably lay in its application. I believe that 75 per cent ether and 25 per cent oil is too strong to use as a routine and that in the reaction it may cause a slough of the mucous surface. It is equally important that the morphin be given prior to the time

of inducing anesthesia. Morphin should not be given even in small doses after anesthesia has been induced. Fortunately, these two points can be readily taken care of, and they should not affect the ultimate popularity of the method.

### INTRATRACHEAL ANESTHESIA

Although intratracheal anesthesia was used in only a few cases in 1927, it comprised 0.14 per cent of the total general anesthetics in 1928. It was not used as extensively as it might have been, still its value was amply demonstrated. I have used either one or two catheters in the trachea. I consider either method to be entirely satisfactory when ether is depended on for anesthesia and relaxation, usually with oxygen or air as a vehicle, but if one attempts to use a minimal amount of ether and depends on either ethylene or nitrous oxid to produce all or part of the anesthesia and relaxation, one should have a catheter or catheters which fill the trachea sufficiently well so that air is excluded. When a tight-fitting catheter, which may be readily introduced into the trachea, is commercially possible, I believe that there will be a great increase in the popularity of intratracheal anesthesia, especially when an attempt must be made to avoid the use of ether or an inflammable gas.

### CARBON DIOXID

Carbon dioxid was used in many more cases in 1928 than in 1927 or any previous year. It was not used as an anesthetic, but as a respiratory stimulant, and it is the almost unanimous opinion of every one in the Section on Anesthesia at the clinic that carbon dioxid is a valuable agent on a gas machine, and that in a large percentage of cases in which a general anesthetic is being used it will facilitate the administration of the anesthetic at one or more times during the period of anesthetization. We have used carbon dioxid to advantage in controlling hiccough both after operation and when operation has not been performed. Results in a series of these cases will be reported at a later date. As yet I have not tried carbon dioxid for early postoperative adynamic ileus.

Carbon dioxid may or may not decrease the explosibility of the anesthetic mixtures while they are in the gas machine, but it has been suggested that it does, and my personal experience in 1928 would lead me to believe that it may. While I was giving 80 per cent ethylene, 5 per cent carbon dioxid, and 15

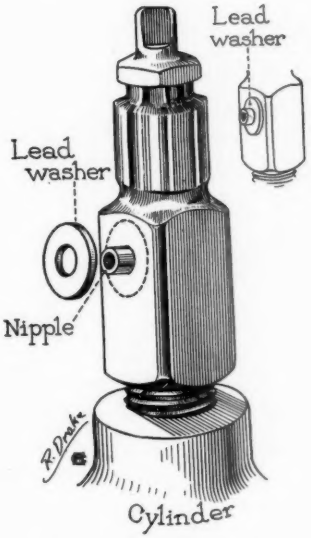


FIG. 351.—Special carbon dioxide outlet which prevents carbon dioxide tanks from being put on any but carbon dioxide yokes on a gas machine. The nipple is removed from the gas machine and incorporated in the valve of the cylinder; the lead washer is then slipped over the nipple and the tank is easily put in place in the yoke on the gas machine. The insert shows the lead washer in place on the nipple; the dotted line indicates the bearing surface of the lead washer surrounding the nipple. This and other similar arrangements are believed to be worth-while safety factors in making anesthesia as fool-proof as possible.

per cent oxygen to a patient I responded to a request to bring a lamp stand closer to the operating table. My hand, being warm and moist, made a perfect contact with the stand, and as a result of a short circuit in the stand I acted as a direct conductor for a 110-volt alternating current which passed in through my

right arm and shoulder, across to my left shoulder, through my left arm to the gas machine, and through its ground wire to the cold water pipe. I was unable to release my hold on the mask or the stand, but staggered away from the patient. The flow of ethylene, oxygen, and carbon dioxid continued without interruption for the few moments before the current was disconnected by pulling the drop cord out of the wall socket. Since then, although untoward results were not experienced, I have urged all anesthetists to wear rubber gloves when using the gas machine in the presence of electric cautery, diathermy, or electric saw. Under such circumstances the ground wire must always be disconnected. It is a good plan for the anesthetist to keep his hands off any electric apparatus while giving an anesthetic. Visitors and others in the operating room also should keep their hands off the gas machine while it is in use.

In a previous article a scheme was demonstrated for eliminating the danger of getting anything but an oxygen cylinder in an oxygen yoke. In 1928 a scheme was developed which seems very practical in eliminating the danger of hanging a carbon dioxid tank on the wrong yoke of the gas machine. Figure 351 illustrates how the strainer nipple has been removed from the yoke and incorporated in the valve of the carbon dioxid cylinder.

## NITROUS OXID

Nitrous oxid was used more often in 1928 than in 1927 or any previous year. It was used as an induction to be followed by ethylene in about half of the total number of cases in which it was used. It was used quite often in preference to ethylene in operating on the thyroid gland, but in at least an equal number of cases ethylene was used. In 47.1 per cent of the cases in which nitrous oxid was used ether was added to avoid anoxemia. Obviously one does not expect much relaxation with nitrous oxid, so it is often necessary to add ether. This, of course, is a dangerous thing to do if diathermy is being used in the mouth while nitrous oxid is given either with a nasal inhaler or intratracheally.

## ETHYLENE

Ethylene was used in a slightly smaller number of cases in 1928 than in 1927. As yet explosions with it have not occurred, and up to January 1, 1929 it was used in 31,764 cases. As an anesthetic agent it has certainly been satisfactory in the majority of cases in which it was used. It has frequently been reinforced with ether in order that there might be no possibility of sudden straining by the patient or of the development of a marked degree of anoxemia.

## ACETYLENE

The use of acetylene in the clinic was begun in 1928 for thoracoplasty and less extensive operations on the chest. With it it has been possible to produce anesthesia and relaxation with quiet breathing, without anoxemia and without the necessity of adding ether. The percentage of oxygen used with acetylene has varied from 20 per cent in the induction period in which nitrous oxid was used up to 70 per cent oxygen and 30 per cent acetylene toward the end of some of the operations. I expect acetylene will be used more in 1929 than it was in 1928 unless some untoward result occurs because of its explosive and inflammable nature.

Acetylene with morphin and without morphin has been used, but I prefer to use a little morphin, although in some instances it has been entirely satisfactory without morphin. If morphin is used, carbon dioxid is particularly valuable. I have used $\frac{1}{6}$ grain of morphin and 1/150 grain of atropin as preliminary medication thirty minutes before anesthesia was begun. The anesthesia is begun and terminated with nitrous oxid and oxygen. Nausea and vomiting seem to be no more frequent with acetylene than with ethylene. Two patients who had previously been nauseated after ethylene were not nauseated after having had acetylene. It is a common observation to have blood pressure rise rapidly after acetylene is started, particularly if the pressure in the breathing bag exceeds 5 mm. of mercury.

Probably if acetylene were to be investigated as extensively as ethylene has been, a product of greater purity, and still better

results might be obtained. However, results thus far have been very gratifying and should continue to be so by a cautious and judicious use of acetylene when ether is contraindicated and ethylene or nitrous oxid with their accompanying anoxemia are undesirable.

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# PAGET'S DISEASE OF THE NIPPLE AND ADENOCARCINOMA OF THE BREAST: REPORT OF A CASE

HAROLD D. CAYLOR

VELPEAU in 1840 and 1841 described a scabby degeneration of the nipple, but his observation received scant attention. Sir James Paget in 1874 described the disorder, and began with the following statement: "I believe it has not yet been published that certain chronic affections of the skin of the nipple and areola are very often succeeded by the formation of scirrhus cancer in the mammary gland. I have seen about fifteen cases in which this happened, and the events were in all of them so similar that one description may suffice."

Since this time many cases (more than 250 by Deaver and McFarland) have been reported. About 10 per cent of the cases of Paget's disease in the literature are extramammary. Controversies soon developed regarding the exact point of origin of the disorder, its significance, and its sequences. A variety of lesions have been considered as Paget's disease and this probably accounts for the number of opinions regarding the disorder. There are four chief opinions regarding Paget's disease: (1) That it is dermatitis or eczema of the skin; (2) that it is primary squamous-cell epithelioma of the skin; (3) that it is a carcinoma developing from the lactiferous ducts in the nipple and suderiferous ducts of the skin, secondarily involving the skin and breast tissue; and (4) that it is a carcinoma beginning deep in the tissue of the breast and growing up along the ducts of the nipple and finally invading the skin. The case reported here illustrates some very unusual features of Paget's disease of the nipple.

A married woman aged thirty-one years came to the clinic because of a "lump" in the right breast which had been present for about three months. The only important feature in the family history was that her mother had had

both breasts removed because of carcinoma. The patient had once been pregnant, but abortion had occurred after six months. The appendix and

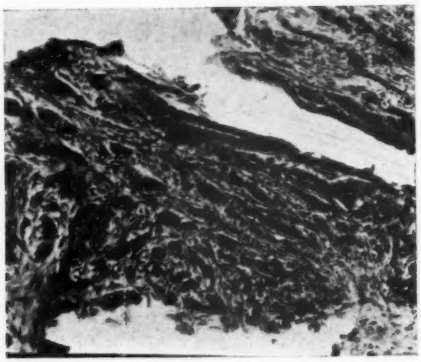

FIG. 352.—Original adenocarcinoma, graded 3, removed from the right breast (× 75).

tonsils had been removed during the year before the first examination at the clinic.

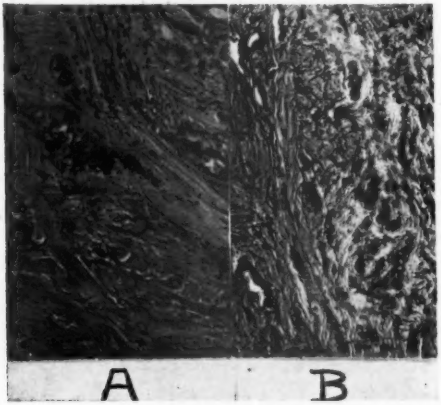


FIG. 353.—*A*, Recurrence of adenocarcinoma, graded 3, in the scar of the former operation; *B*, second recurrence of adenocarcinoma in the scar of the breast amputation (× 75).

Examination revealed a tumor about 1.5 cm. in diameter at the extreme outer edge of the right breast (9 o'clock position). This new growth was firm, nodular, and movable and was not attached to the skin. Excision was

advised, to be followed immediately by radical amputation of the breast if the growth was malignant. Microscopic examination of the tumor immediately after its removal revealed adenocarcinoma, graded 3 (Fig. 352), according to Broders' system of grading.[1] A modified radical amputation of the right breast and axillary lymph-nodes was performed at once. The right nipple was not removed because the tumor was so far to one side that it did not seem necessary to remove it; besides, the patient desired that the nipple should be saved if possible. There was no evidence of adenocarcinoma in any of the right axillary lymph-nodes that were removed.

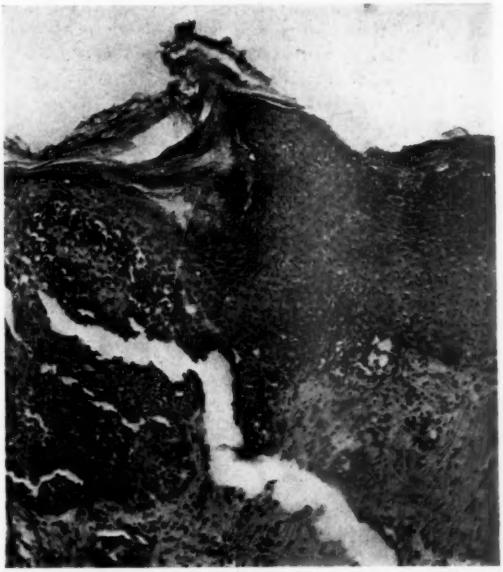

FIG. 354.—Except for hyperkeratosis and slight epithelial hyperplasia most of the epithelium shown in the right half of the photomicrograph is unchanged; in the left half of the picture there is irregularity of the cells with the appearance of cells of Paget's disease (× 75).

For approximately a year the patient was in excellent health. Then she noticed a small firm nodule in the operative scar. This nodule was excised and proved to be adenocarcinoma, graded 3 (Fig. 353, *A*). Irradiation by roentgen rays and radium was administered.

Seven months after these procedures a small nodule was again noted in the scar of the former operation. This tissue was excised and found to be adenocarcinoma, graded 3 (Fig. 353, *B*). Treatment by radium and roentgen rays was given over the area of the breast following this minor operation.

For eight months the patient's health was excellent. A few weeks before her return to the clinic she noticed pain and a slight discharge from the right nipple. Occasionally the discharge was bloody, and occasionally it was purulent. Examination of the nipple did not reveal visible change, but because the breast had been removed previously for adenocarcinoma the nipple was excised.

This tissue was examined microscopically and proved to be composed largely of squamous epithelium that was especially altered in its deeper layers. The rete pegs (rete malpighii) were irregular and were composed of large round or oval vacuolated cells with single or multiple nuclei resembling in every particular the cells described as diagnostic of Paget's disease (Fig. 354). Lymphocytes and infiltration of plasma cells in the deeper layers of the skin were insignificant. Sekiguchi believes that as a rule the longer the duration of Paget's disease the greater the infiltration of plasma cells. Considering this sign and the short history given by the patient, Paget's disease was probably of brief duration.

## COMMENT

Much interest developed in this disorder early because it was felt that in a study of Paget's disease there might be found factors which influenced the development of malignant changes in the breast. From these descriptions and studies the opinion developed that patients with this disorder apparently had dermatitis or eczematous eruption of the nipple and areola which in time became malignant or was frequently associated with malignant changes of the tissue of the breast.

In discussing Paget's disease Deaver and McFarland have suggested three possibilities as follows: "(1) The disease is secondary to the occurrence of cancer in the breast, and results from the action of cancer toxin on the epiderm, or from the upward growth of cancer cells and their invasion of the skin, as supposed by a number of observers, . . . (2) the disease is primary, may occur without antecedent or subsequent cancer or after varying length of time may lead to cancer of the squamous-cell variety through the disturbances in the papillary layer of the skin, or to glandular cancer, when a gland is subjacent by extending into the ducts where they communicate with the diseased skin, . . . or (3) the disease is an independent entity having no more to do with the occurrence of cancer than lupus of the skin that is occasionally followed by squamous-cell cancer and is precancerous only in opening an avenue by which the true

cause of cancer may be admitted to the tissues in which it finds suitable nidus for its development. Of these possibilities it seems to us that the first is supported by the least evidence and is contradictory to the known facts regarding the disease. Our sympathy is therefore with the other two which cannot be said to be contradictory with the facts regarding the disease or with one another."

Each of the main theories regarding the origin of Paget's disease has proponents; Duhring and Wile, Sekiguchi, Jacobaeus, and others, assert that Paget's disease is a carcinomatous process developing in the ducts of the breast and involving the skin and deeper structures of the breast later. Rubenstein, Yoakem, Pautrier, and Darier, on the other hand, are of the opinion that the disorder is epitheliomatous and arises in the basal layer of the epithelium or the more superficial layers of the duct epithelium.

From the histologic appearance and from the clinical course of Paget's disease there is evidence that the extramammary manifestations of the disorder and Bowen's dermatosis are similar and may be the same affection. Rubenstein and Fraser have mentioned this similarity. I believe that the diseases are closely related and perhaps identical. Darier and Ewing, however, are of the opinion that Bowen's disease differs from Paget's disease.

The case reported here illustrates some unusual features. The patient had carcinoma of the breast followed at intervals of months by two recurrences of adenocarcinoma. Finally, following an interim of months, Paget's disease of the nipple was discovered. This is quite the reverse of the usual sequence of events which are characterized by the formation of the lesion of the nipple, and after an interval varying from months to years carcinoma of the breast is sometimes discovered. I agree with Broders,[2] that "mammary Paget's disease per se is a squamous-cell epithelioma, usually of a low grade of malignancy. It not uncommonly is associated with adenocarcinoma that has its origin in the glandular portion of the breast. It may also be associated with carcinomatous change in the duct epithelium.

Furthermore, as a rule, these malignant processes are entities and are not due to invasion from one situation to another."

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# THE ARTERIAL BLOOD SUPPLY OF THE SIGMOID, RECTOSIGMOID, AND RECTUM

CHARLES E. POPE AND E. STARR JUDD

THE importance of the arterial blood supply to the lower part of the bowel has been emphasized since the time of the first Kraske operation. Suedeck and Hartman, and others have called attention to the vessels of the mesocolon of the sigmoid as a contributary or sole factor in vascular postoperative necrosis following operation in this region. Suedeck, in 1907, and Hartman, in 1909, first described the point of union of the last sigmoid artery with the superior hemorrhoidal artery just beyond the promontory of the sacrum. This was described as a point of weakness in the blood supply to the rectum because it is the last point of union of the arcading sigmoid arteries to the main artery of blood supply to the rectum, the superior hemorrhoidal artery, which is continuous and analogous with the inferior mesenteric artery from the lower part of the aorta. Consequently these investigators attempted to show that if the superior hemorrhoidal artery is ligated above this point of union or the "critical point," blood could course from a point of dependency above the point of ligation by means of a shunt through the last sigmoid arterial union maintained below, whereas ligation below the point of union would cut off blood both from the inferior mesenteric artery and the last anastomosing arcade to the sigmoid, through the last sigmoid artery. It was then argued that vascular necrosis would occur because the sole blood supply was supposed to be carried from a point superior to a point inferior, that is, through the inferior mesenteric source. To the present time this has been universally accepted. This explanation, however, has not been wholly accepted as a prime cause for the high postoperative mortality following operation

on the lower part of the bowel, necrosis, sloughed bowel, and peritonitis too frequently having followed careful operation in the region of the rectosigmoid in spite of preservation of the vessels. The high surgical mortality from operation in this region is not to be compared to that of operation elsewhere in the colon.

One of us (Judd) has often noted that vascular embarrassment is to be seen even at the time of operation following manipulation in the lower part of the bowel, and discoloration and venous congestion may often be seen as an indication of arterial ischemia in a severed loop of rectosigmoid. It was reasonable to suppose, therefore, that the so-called critical point did not afford an adequate explanation. The results of our studies have fully justified our original belief. They may be outlined briefly as follows:

1. Surgical procedures are precarious in the region of the rectosigmoid because of the value of the blood supply.

2. The so-called critical point per se is a misnomer.

3. The lower part of the rectum has an extensive system of collateral blood-supply.

4. On this account the inferior mesenteric artery and its continuation, the superior hemorrhoidal artery, do not constitute the sole blood-supply to the lower part of the bowel when intact and in situ.

5. The main cause for the high postoperative mortality following operation in this region is due to encroachment on the region of the rectosigmoid and the severance of hitherto unrecognized arteries, which we have named the rectosigmoid arteries from their point of origin.

A review of the arteries supplying blood to the lower part of the bowel will afford a better understanding of the study at hand. The inferior mesenteric artery arises about 3.7 cm. above the bifurcation of the aorta. It courses to the left and downward, then medially, and in its course gives off the sigmoid arteries to the sigmoid. These radiate outward as the spokes of a wheel and form arcading loops with their adjacent members that thereby form a pattern which is more or less complex,

depending on the number of branches that each gives off. The upper sigmoid artery unites in like manner with the left colic artery which arises from the inferior mesenteric artery close to its point of aortic origin; the last sigmoid artery sends a branch that unites with the superior hemorrhoidal artery beyond the promontory of the sacrum in the pelvis. This artery, the superior hemorrhoidal artery, is the direct continuation of the inferior mesenteric artery, and the superior border of the left common iliac marks this point of division one from the other. The superior hemorrhoidal artery in turn bifurcates or trifurcates on the posterior aspect of the rectum near the upper boundary of the rectum, the third sacral segment, and its branches course downward and encircle the rectum at its lower portion anteriorly, its branches supposedly supplying intervening bowel wall in like fashion. The remaining blood supply to the rectum has been described meagerly as consisting of a middle hemorrhoidal artery on either side arising from the anterior hypogastric artery on the internal pudic artery close to its point of origin, and one or two inferior hemorrhoidal arteries from the internal pudic artery at the ischiorectal fossa on either side, and the middle sacral artery from the lower portion of the aorta. These arteries are described as extending to the lower part of the rectum and upper anal canal anastomosing with each other, and the superior hemorrhoidal artery branches by a fine series of anastomoses.

The material studied naturally falls into four divisions: (1) The arterial pattern of the mesocolon of the sigmoid; (2) the arteries of the rectum; (3) the collateral blood-supply to the rectum; and (4) the arteries of the region of the rectosigmoid.

Early in our study we found that knowledge of the arteries of the regions of the sigmoid and of the rectum was necessary for an appreciation of either of these two regions or of the region of the rectosigmoid. Our investigations were carried out by means of dissection, dye injection in unembalmed specimens injected in situ, cleared specimens injected with gelatin and India ink, mercury injections followed by stereoroentgenograms, and corrosion specimens of celluloid injected arteries. We were thus able to correlate our data and demonstrate the arteries to

the lower bowel and their collateral system of anastomoses. Briefly, the results of this study are as follows:

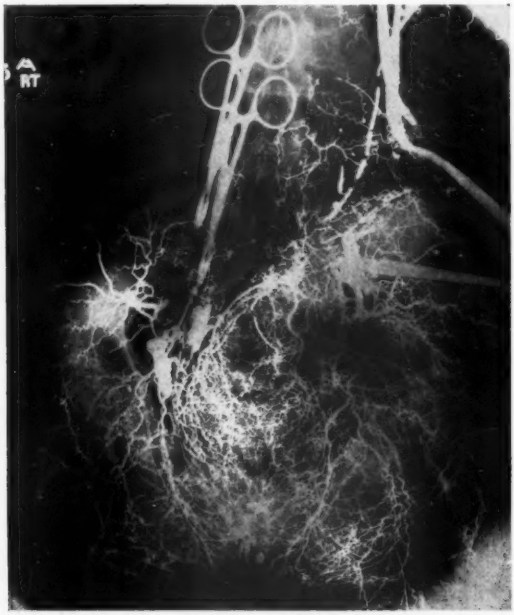


FIG. 355.—Mercury in situ in the arteries of the lower part of the bowel. This completely injected specimen shows clearly the extensive system of collateral anastomoses in the pelvic arteries and accordingly demonstrates the dependency of circulation from below upward in the intact bowel. The numerous vessels crossing toward the rectum in its lower quarter may be seen. Small barium particles outline the anal orifice and a homogeneous mixture of the same nature outlines the lumen of the bowel. The hemostats clamp the iliac vessels and the middle sigmoid bowel. The superior hemorrhoidal artery bifurcates at the middle of the pelvis and the branches of the recto-sigmoid are seen descending beyond this point and over halfway down the rectum on either side. This injection of mercury was made through the inferior mesenteric artery, but the same picture may be obtained by injection of the hypogastric artery. It is apparent that the superior hemorrhoidal arteries are not the sole source of the blood supply to the rectum. Stereoscopic study of this picture is necessary to demonstrate these points clearly.

The injection of dye into unembalmed specimens in situ (Fig. 355) showed an extensive collateral system of anastomoses

in the pelvic among: (1) The superior and inferior gluteal arteries; (2) the internal pudic artery; (3) the superior, middle, and inferior hemorrhoidal arteries; (4) the iliolumbar arteries; (5) the

FIG. 356.—Mercury injected in situ into the arteries of the lower part of the bowel. The hemostats are clamped on the internal and external iliac arteries. The cannula is inserted into the aorta through the inferior mesenteric artery. The sigmoid partially fills the right iliac fossa as well as the left. The bifurcation of the superior hemorrhoidal artery and the first rectosigmoidal artery or the so-called critical point is plainly seen. The specimen was not completely injected in the pelvis, but the main arteries to the rectum are plainly outlined. The middle sacral artery may be seen entering into the retrorectal arterial plexus. Several branches from the internal pudic arteries on either side are middle hemorrhoidal arteries.

lower lumbar arteries; (6) the middle and lateral sacral arteries, and (7) the inferior mesenteric artery. It was clearly shown that these vessels were concerned, since the anastomosis was so extensive that an injection of various of these arteries always

resulted in an injection of the whole system. That is, if the anterior branch of the hypogastric artery was injected and the common iliacs clamped, the dye injected extended into the whole bowel with ease and rapidity, and even entered these various arteries. This demonstrated that there is a much more intimate connection between the systemic source and the splanchnic source than has been appreciated and that in the intact bowel in situ in vivo there is a dependency of circulation that may occur from below up as well as from above down (mesenteric or splanchnic source). By such means we were early able to show that the so-called critical point does not exist in the intact bowel, for ligation of the superior hemorrhoidal artery below its point of union with the last sigmoid artery did not prevent the flow of dye from a point of injection in the anterior hypogastric artery to the level of the point of ligation, and injection simultaneously through the inferior mesenteric artery thereby completed a full arterial injection into the lower part of the bowel.

It remained therefore to determine how these various anastomoses occurred, the dye injection showing that there are extensive anastomoses. A method was accordingly developed whereby mercury was injected into specimens in situ and stereoroentgenograms taken (Fig. 356). In this way a proper perspective was attained, and the arteries, their points of anastomoses, and their ultimate connections to the wall of the bowel were determined. It was found that instead of a single middle hemorrhoidal artery on either side to the rectum, there were always three and sometimes five on either side. These originate from the anterior branch of the hypogastric artery and the internal pudic artery in its downward course, and supply the lower part of the rectum. There may also be two to four inferior hemorrhoidal arteries from the internal pudic artery on either side. It was also found that in the lower half of the rectum a fine system of retrorectal vessels connected the middle sacral and lateral sacral arteries with the gluteal arteries and the hemorrhoidal arteries. Some of the gluteal branches assumed a size sufficient to deserve the name of middle hemorrhoidal arteries and acted as such.

The region of the rectosigmoid has been defined as being the wall of the bowel at the level of juncture between the rectum

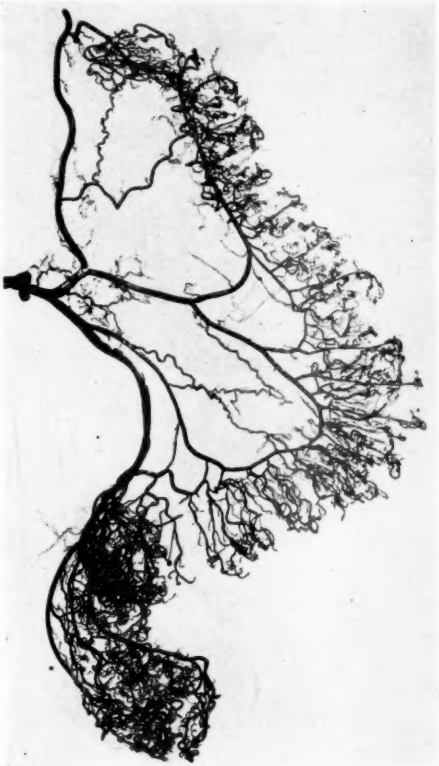

FIG. 357.—Celluloid cast of the arteries of the descending colon, sigmoid, and rectum. From the so-called critical point may be seen a descending rectosigmoid artery, its outline clouded by the sigmoid flexure, but its course most evident as continuing anteriorly and laterally halfway down the rectum; it is abetted by a second rectosigmoid artery having its origin just inferiorly. The three main vessels in the rectum are branches of the superior hemorrhoidal artery, the left and the right, the latter giving, close to its point of origin, the middorsal artery to the rectum. The injection was made through the inferior mesenteric artery at its point of origin. A few twigs to the wall of the bowel were broken just above the first rectosigmoid artery. It is anatomically in its correct position.

and the sigmoid or at about the third sacral segment. This indefinite landmark formed an obstacle at first because it was difficult to determine the site of the vessels to the rectosigmoid. That is, it was found that although the third sacral segment is a definite stationary landmark the rectum itself might be more or less mobile, according to various factors, and the sigmoid flexure was also no criterion to its position. A study of the vessels of the mesocolon of the sigmoid showed, however, that the bifurcation of the superior hemorrhoidal vessels occurred always at about the second to third sacral segment, just to the left of the median line, and this point was not a fluctuating inconstancy, but always to be found at about the same position. Another point of significance was that although the sigmoid might vary considerably in length the inferior mesenteric-superior hemorrhoidal artery from its aortic origin to this point of bifurcation or trifurcation remained fairly constant. It was immediately apparent therefore that the region of the rectosigmoid might better be defined according to its vessels, particularly if the region were distinctive because of its blood-vessels.

Injections of mercury with stereoroentgenograms in situ and not in situ, and celluloid corrosion casts were made of the arteries to the wall of the bowel in the region of the rectosigmoid, and by these methods the region of the rectosigmoid was determined and its arteries studied (Figs. 357, 358).

The region of the rectosigmoid is peculiar in having long slender arteries originating from the superior hemorrhoidal artery or its right or left branch that are generally characterized by paralleling the superior hemorrhoidal artery in their course and on entering the wall of the bowel sending laterally spreading branches. This type of artery peculiar to this region and not to be seen in the descending colon or sigmoid proper is present from the level of the so-called critical point nearly to the tip of the coccyx or half way down the rectum. The point of union of the last sigmoid artery with the superior hemorrhoidal artery is always a point of origin for the rectosigmoid artery. It is therefore a rectosigmoid artery trunk which sends an upper branch of union with the last sigmoid artery, as do the sigmoid

arteries with their adjacent members, thus carrying out the same plan of pattern as is seen in the mesocolon of the sigmoid. The rectosigmoid arteries may be five in number, or only one. Their further importance is shown by the fact that the upper anterior and lateral aspects of the rectum are supplied by them, and not

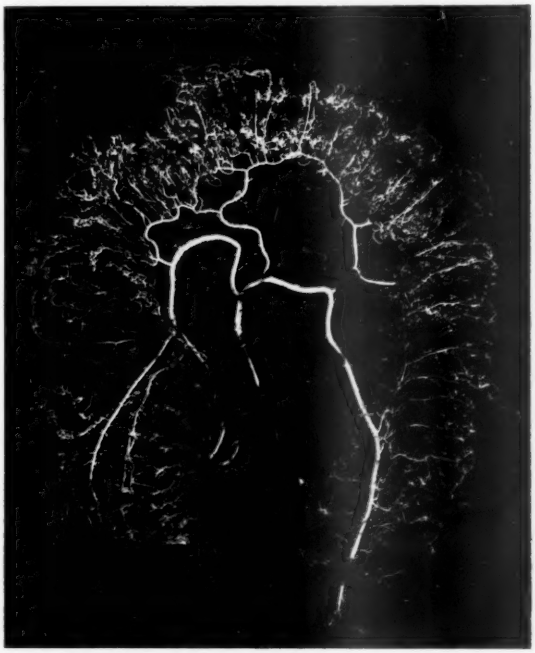

FIG. 358.—Celluloid cast of the arteries of the descending colon, sigmoid, and rectum. The cannula marks the origin of the inferior mesenteric artery. The rectum, on the left, is spread open somewhat and demonstrates three rectosigmoid arteries; the first from the superior hemorrhoidal artery with a large ascending branch of union with the last sigmoid artery (the so-called critical point or union of the last sigmoid artery with the superior hemorrhoidal artery); the other two are from the superior hemorrhoidal artery just beyond its point of bifurcation. The specimen is unusual in that the latter two rectosigmoid arteries are ascending and supply the wall of the bowel as high as the first rectosigmoid artery, while the first does not descend as it does ordinarily and supplies the portion of the bowel wall only directly opposite to its point of origin. Anastomosis is not present between the first artery and its fellows below.

alone by the superior hemorrhoidal arteries, as has been supposed. The right and left lateral anterior and partial posterior aspects of the upper half of the rectum always receive blood from these arteries. Some variation is to be found, as, for example, a rectosigmoid artery descending as does a superior hemorrhoidal artery for the full rectal length; for example, an anastomosis with a superior hemorrhoidal artery so marked as to be almost indistinguishable from that artery save in its early course. On the whole, however, when these arteries originate from the superior hemorrhoidal artery they are descending, when from its right or left branch, usually right, they are ascending. The anastomotic connections between the superior hemorrhoidal arteries and the rectosigmoid arteries are not marked and are not always present. The right branch of the superior hemorrhoidal artery, however, frequently anastomoses with a descending branch of the rectosigmoid artery about halfway down the rectum on its right lateral aspect in the wall of the bowel.

As has been mentioned, the inferior mesenteric artery from its point of origin to the point of the superior hemorrhoidal bifurcation maintains a fairly constant length, regardless of the type of bowel or complexity of arterial mesocolon pattern. This point of bifurcation or trifurcation occurring constantly at about the second to third sacral segment marks the middle zone of the region of the rectosigmoid. It is possible, therefore, to determine the region of the rectosigmoid by means of this arterial constancy. It measures on the average about 18 cm. If one measures this distance on the lateral or ulnar aspect of the left hand, from finger-tip to wrist, and places the hand so that the wrist marks the point of origin of the inferior mesenteric artery on the lower aorta, the hand may describe the course of the inferior mesenteric-superior hemorrhoidal artery if it is semiflexed, and by allowing the finger to droop into the pelvis encircling the bowel in this region, the finger-tip may rest at the point of division of this artery at the posterior rectal aspect. In this manner in most obese persons as well as in persons with redundant sigmoid, the region of the rectosigmoid may be determined, at its middle portion.

It is important to determine the region of the rectosigmoid. Examination of these specimens has shown that due to the peculiarity of these arteries of the rectosigmoid, surgical procedures under certain conditions could easily be disastrous by reason of vascular ischemia. If the stump of a blind end of sigmoid or the upper part of a rectum should be left following resection, and the region of the wall of the bowel left should happen to include the region of the rectosigmoid, the rectosigmoid arteries will have been severed in consequence, and it is extremely likely that the region dependent on them for blood-supply would necrose. The extent of vascular embarrassment would depend on the particular type of specimen and the more or less accentuation of a laterally spreading type of artery or on the presence of a long descending or ascending type of rectosigmoid artery. Whereas there are anastomotic branches between the rectosigmoid arteries and the superior and middle hemorrhoidal arteries it is apparent that these points of anastomoses are often not sufficient to carry on the circulation to adjacent regions where the rectosigmoid arteries have been severed. In fact, the arteries of the lower part of the colon and the rectum are peculiar in that after gradual penetration from serosa through the muscularis they form a continuous arteriolar chicken-wire type of submucosal anastomosing network. This permits an even distribution of blood to the wall of the bowel in an intact specimen, but is not sufficient to carry on the circulation per se, if the larger arteries, such as the rectosigmoid arteries, are severed, because of the smallness of these arterioles.

## SUMMARY

The region of the rectosigmoid extends from the so-called critical point half way down the rectum. It is a region peculiar in the type of arteries to the wall of the bowel. There are from one to five of these arteries. They may originate from the superior hemorrhoidal artery above, at or below its point of division at the third sacral segment. They are characterized by paralleling the superior hemorrhoidal artery in their course and

on entering the wall of the bowel having laterally spreading branches.

The so-called critical point is always the point of origin of a rectosigmoid artery, and it is, therefore, the first rectosigmoid artery.

The upper half of the rectum is always supplied by the rectosigmoid arteries, for the main part on its right and left lateral, anterior, and partial posterior aspects.

The region of the rectosigmoid may be determined by its arteries. At the time of operation it may be found by reason of the constancy in length of the inferior mesenteric-superior hemorrhoidal artery which bifurcates or trifurcates at approximately the median zone of the region of the rectosigmoid.

The lower part of the bowel has a much more adequate blood-supply than has been appreciated. Consequently in the intact bowel there is a dependency of circulation that may occur from below up as well as from above down, showing a considerable intimacy of anastomoses between the systemic and splanchnic systems of vessels.

The more important surgical points gained by the study seem at the present time to be: (1) Wide resection of the lower part of the colon and rectum to include the region of the rectosigmoid; (2) definition of the rectosigmoid and its identification by knowledge of its arterial blood supply; (3) preservation of as much as possible of the pelvic mesocolon pattern; (4) high ligation of the inferior mesenteric artery; (5) safety in leaving a low-lying rectal stump for anastomosis or otherwise because of the dependency of circulation from below upward, and (6) the size of the mesocolon is not indicative of the arterial pattern.

# THE EFFECT ON THE CIRCULATION OF THE INJECTION OF 10 PER CENT GLUCOSE AND 1 PER CENT SODIUM CHLORID FOLLOWING OPERATION

STEPHEN A. YESKO, LUIS A. PASSALACQUA, AND E. STARR JUDD

FOLLOWING operation, in cases in which medicaments or food cannot be introduced satisfactorily by other channels, modern treatment demands careful intravenous injections, as a means of saving or prolonging a patient's life. Blood is a fluid-tissue of most delicate physical and chemical balance, which necessitates a careful selection of the medicament used. After extensive research it has been found that glucose in an isotonic solution is one of the best medicaments, and from its use excellent results have been reported. According to Litchfield, glucose is harmless and preferable to sodium chlorid in such states as acidosis and toxemia, whereas Valk advocated the use of glucose in postoperative acidosis with persistent nausea and vomiting. Although intravenous injection flourished in the nineteenth century, its modern application dates to the work of Christopher Wren[6] who practised intravenous injection in man and animals. During the eighteenth century this treatment advanced as a result of careful experimental work conducted along toxicologic and pathologic lines. It may be mentioned that during this period many attempts were made to cure the ravaging effects of tetanus and hydrophobia by intravenous medication.

The modern epoch in intravenous treatment began with the understanding of the physiologic and bacteriologic principles. Baccelli made the first report on the use of quinin given intravenously for the cure of malaria. In 1901 Credé established the use of silver salts in all kinds of infections. As a result, a new school of intravenous therapy was started, and many and varied drugs were used for injection.

Beard and Beard noted leukopenia in rabbits immediately after the intravenous injection of 10 to 15 c.c. of physiologic sodium chlorid solution, and leukocytosis followed a few hours later. Leukocytosis was also reported in an adult patient by Bluemel and Lewis following the intravenous injection of sodium chlorid solution. There are many reports in the literature on observations regarding the distribution of leukocytes in the peripheral blood following proteins and various other substances, showing an increase in the leukocyte count. In the present study several observations were made of the changes which follow the intravenous use of glucose and sodium chlorid solution.

## EFFECT ON BLOOD PRESSURE AND PULSE

**Method of study.**—Studies were conducted in a hospital in which from 3,000 to 4,000 injections of 10 per cent glucose and 1 per cent sodium chlorid are administered postoperatively annually. Patients are carefully studied clinically as regards the condition of the heart, the blood vessels, and renal function before the injections are given. The usual site of injection is the median cephalic and basilic veins. The gravity method with the use of a graduated tube is employed in all cases. The average rate for the injection is 15 c.c. each minute, and the average injection period is from half an hour to one and a quarter hours. The fluid is maintained at body temperature. To obtain an initial level, the blood pressure and pulse rate are taken before

TABLE 1

EFFECT OF INJECTION OF 1000 C.C. 10 PER CENT GLUCOSE AND 1 PER CENT SODIUM CHLORID

| Time, P. M. | Period. | Systolic. | Diastolic. | Pulse. |
|---|---|---|---|---|
| 3.05 | Before injection. | 130 | 58 | 94 |
| 3.10 | During injection. | 136 | 56 | 98 |
| 3.15 | ..... | 140 | 58 | 96 |
| 3.20 | ..... | 140 | 58 | 98 |
| 3.25 | ..... | 140 | 56 | 104 |
| 3.30 | ..... | 136 | 52 | 100 |
| 3.35 | ..... | 130 | 52 | 100 |
| 3.40 | End of injection. | 136 | 52 | 96 |

TABLE 2

EFFECT OF INTRAVENOUS INJECTION OF 1000 C.C. 10 PER CENT GLUCOSE AND 1 PER CENT SODIUM CHLORID ON BLOOD PRESSURE AND PULSE

| Case. | Age, years. | Date. | Surgical diagnosis. | Blood pressure. | | | | | | | | Pulse. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Before injection. | | After injection. | | Half hour after injection. | | One hour after injection. | | | | | |
| | | | | Systolic. | Diastolic. | Systolic. | Diastolic. | Systolic. | Diastolic. | Systolic. | Diastolic. | Before injection. | After injection. | Half hour after injection. | One hour after injection. |
| 1 | 35 | 10/31/28 | Cholecystectomy | 112 | 90 | 140 | 80 | 130 | 88 | 106 | 88 | 88 | 106 | 90 | 90 |
| 2 | 65 | 11/ 2/28 | Carcinoma of common bile-duct | 130 | 80 | 120 | 80 | 128 | 82 | 130 | 82 | 80 | 90 | 86 | 82 |
| 3 | 50 | 11/ 3/28 | Carcinoma of common bile-duct | 90 | 50 | 88 | 48 | 102 | 58 | 108 | 70 | 82 | 94 | 82 | 80 |
| 4 | 52 | 11/ 4/28 | Carcinoma of rectum | 128 | 90 | 140 | 88 | 138 | 88 | 138 | 90 | 100 | 110 | 108 | 110 |
| 5 | 50 | 11/ 5/28 | Carcinoma of rectum | 100 | 68 | 120 | 70 | 118 | 70 | 110 | 70 | 102 | 120 | 118 | 112 |
| 6 | 40 | 11/ 6/28 | Carcinoma of ilium | 128 | 48 | 120 | 40 | 122 | 40 | 120 | 48 | 92 | 104 | 100 | 96 |
| 7 | 30 | 11/10/28 | Cholelithiasis | 110 | 80 | 128 | 70 | 120 | 80 | 112 | 80 | 100 | 116 | 104 | 102 |
| 8 | 35 | 11/11/28 | Carcinoma of rectum | 120 | 74 | 128 | 60 | 118 | 64 | 120 | 64 | 118 | 128 | 110 | 116 |
| 9 | 50 | 11/12/28 | Cholelithiasis | 100 | 40 | 120 | 30 | 110 | 38 | 100 | 40 | 140 | 152 | 146 | 150 |
| 10 | 40 | 10/30/28 | Nephrolithiasis | 110 | 78 | 110 | 70 | 100 | 68 | 100 | 68 | 100 | 120 | 110 | 104 |
| Average | | | | 112.8 | 69.8 | 121.4 | 63.6 | 118.6 | 56.6 | 113.6 | 70.0 | 100.2 | 114.0 | 105.4 | 104.2 |

and after each injection, and at various intervals. In Table 1 readings which were taken every five minutes during the period of injection are recorded; in Table 2 another series of readings made every half hour, until the blood pressure and pulse rate returned to the pre-injection level, is recorded.

**Results.**—The average initial level for the readings was 112.8 mm. of mercury for the systolic phase and 69.8 for the

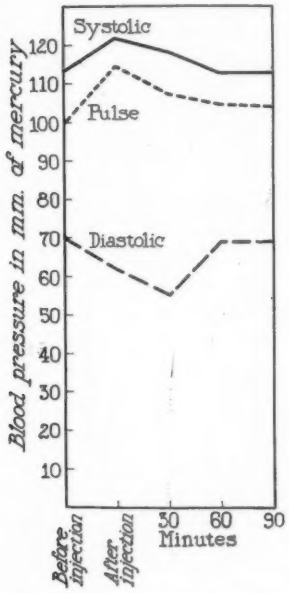


FIG. 359.—Blood pressure before and after injection of glucose.

diastolic phase, although there was considerable variation (Table 2). The maximal systolic reading in the pre-injection stage was 130 and the minimal was 90. The maximal diastolic reading was 90 and the minimal 40. In the half-hour readings after the injection, the systolic pressure was increased during the first half hour from an average of 112.8 to 121.4, representing an increase of 8.6 (Fig. 359). In the diastolic records there was a marked drop from the initial (69.8) level to 63.6, or a drop of

6.2. Analyzing the results obtained at the end of the first half hour after injection, the systolic and diastolic averages were 118.6 and 56, respectively. At the end of one hour the readings dropped from the peak it attained to a new level, which was slightly above the pre-injection mean.

**Comment.**—The results were taken to show that in all cases the readings for the blood pressure and pulse rate rose considerably higher than the initial value for a period from half to one hour, following the injection, but returned exactly to the pre-injection level for the remainder of the record. The systolic pressure dropped from the high point it attained in about half an hour following the injection, and the diastolic fell from a high level before the injection to a lower level after the injection.

TABLE 3

EFFECT OF INJECTION OF 1000 C.C. 10 PER CENT GLUCOSE AND 1 PER CENT SODIUM CHLORID ON LEUKOCYTE, ERYTHROCYTE, AND HEMOGLOBIN READINGS

| Case. | Leukocytes, thousands. | | | | Erythrocytes, millions. | | | | Hemoglobin, per cent. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before injection. | After injection. | Three hours after injection. | Twenty-four hours after injection. | Before injection. | After injection. | Three hours after injection. | Twenty-four hours after injection. | Before injection. | After injection. | Three hours after injection. | Twenty-four hours after injection. |
| 1 | 19.4 | 15.6 | 20.8 | 15.0 | 3.77 | 3.33 | 3.45 | 3.13 | 64 | 61 | 62 | 55 |
| 2 | 21.3 | 15.3 | 23.6 | 20.3 | 3.13 | 2.79 | 3.06 | 3.13 | 60 | 54 | 58 | 55 |
| 3 | 12.7 | 18.4 | 13.4 | 8.5 | 4.73 | 4.43 | 4.51 | 4.20 | 85 | 85 | 85 | 85 |
| 4 | 12.5 | 7.8 | 12.9 | 10.2 | 3.50 | 3.43 | 3.48 | 3.04 | 55 | 54 | 55 | 55 |
| 5 | 20.3 | 13.4 | 18.5 | 15.2 | 3.13 | 2.65 | 2.75 | 2.60 | 55 | 50 | 50 | 50 |

Interpreting these results physiologically it would seem that in man, as in experimental animals, a large volume of 10 per cent glucose and 1 per cent sodium chlorid given intravenously leaves the blood stream soon after the first hour following the injection. The remainder of the solution soon follows into the lymph and urinary channels, and about an hour is required before the original volume is restored. The high systolic rise was only transitory, showing the working power of the heart. The diastolic readings, on the other hand, showed a marked constant dropping, which really means the register of the peripheral

resistance and the tonus of the arterioles. It affords more reliable information than the systolic concerning the work required of the heart. The return of these vascular pressures to a normal level implies that the completion of fluid passage from the vascular channels into the tissues has taken place. There is much speculation as to the exact cause of hypotension following extensive surgical procedures. Following experimental research with histamin in which a marked reduction of blood pressure has been shown to follow small doses of this substance injected intravenously, many recent investigators believe that a new substance, similar in action, is formed in the body, which causes a reduction of blood pressure.

Since the changes in the pulse rate were the same in every case, and always showed an increase from 10 to 20 pulsations for each minute, half an hour after the injection, one can only construe it to mean the working force of the heart in driving the blood to the periphery, or necessarily the load that the heart muscle must carry to maintain the circulation.

**Method of Study.**—Ten unselected patients received 1,000 c.c. of 10 per cent glucose and 1 per cent sodium chlorid solution intravenously. There was no untoward reaction. Leukocytes were counted before the injection, immediately after injection, and three hours afterward. In three of the patients a fourth count was made twenty-four hours later. In seven patients hemoglobin determinations and erythrocyte counts were made, following the same plan. The time selected to make the counts was arbitrary.

**Results.**—This series of cases falls into two groups of five cases each. In the first group are included all cases in which the initial count was more than 12,000; in the second group those in which the leukocytes were less than 12,000. Again, all the cases in which erythrocytes numbered more than 4,000,000 formed a different group as compared to those in which the count was less than 4,000,000.

Irrespective of grouping, there was a decrease in the leukocytes following the intravenous injection. In one case there was a drop of 6,900 cells. Furthermore, all counts done three hours

after the injection revealed a secondary increase in the number of cells (Fig. 360). Again, in nine of the ten cases the rise exceeded the initial count.

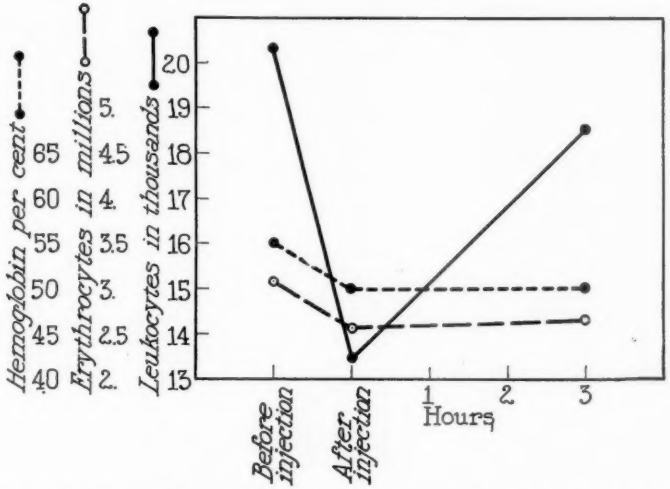


FIG. 360.—Hemoglobin readings and erythrocyte and leukocyte counts before and after injection of glucose.

## EFFECT ON PERIPHERAL BLOOD

The first group was characterized by a great drop in the leukocyte count immediately after the administration of the solution, followed three hours later by a return to a level close to the initial one. In the second group the drop was not so marked but the secondary rise exceeded the count done previous to the injection by an average of 65 per cent.

In all the cases there was a decrease in the number of erythrocytes after the injection, followed by a secondary rise three hours later. The last count was never so high as the initial one. On the other hand, in cases in which erythrocytes numbered less than 4,000,000 the hemoglobin percentage of the blood dropped, and in those in which the erythrocytes numbered more than 4,000,000 the hemoglobin remained the same.

**Comment.**—The injection of 1 liter of fluid into the circulation is likely to produce temporary dilution of the blood by increasing the plasma volume. There is no evidence to prove that the solution used in this study, which has been given thorough clinical trial, is detrimental to the formed elements of the blood. The drop in the cell count after the injection is due to this increase in the proportion of the blood plasma. This is substantiated by the uniformity of the fall which comprised all the elements studied, with the exception of three hemoglobin determinations in cases in which the erythrocytes numbered more than 4,000,000 for each cubic millimeter of blood.

There is a stimulating effect in the production of the leukocytes by the injection of glucose and sodium chlorid into the blood vessels which usually amounts to definite leukocytosis, unless leukocytosis is already present, in which case, there is only a return within the previous limits at the end of three hours.

## SUMMARY

The intravenous injection of a relatively large quantity of 10 per cent glucose and 1 per cent sodium chlorid caused a temporary rise in blood pressure and pulse rate. These alterations, although marked during and after injection, were not continued for any length of time.

After the introduction of 1,000 c.c. of 10 per cent glucose and 1 per cent sodium chlorid, there was a decrease in the number of erythrocytes immediately after the injection, with a gradual rise to a point slightly below the pre-injection level.

After the use of glucose and sodium chlorid in large quantities a marked drop in leukocytes occurred followed by frank leukocytosis at the end of three hours.

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# MULTIPLE ABSCESSES OF A FRONTAL LOBE OF THE BRAIN: MENINGIOMA OF THE SPINAL CORD WITH EXTRADURAL SPREAD

JAMES R. LEARMONTH

## MULTIPLE ABSCESSES OF A FRONTAL LOBE OF THE BRAIN

IN the absence of a localized suppurative focus, to which abscesses of the frontal lobe of the brain may owe their origin, certain difficulties in diagnosis and treatment are presented. In the following case the only doubtful point in diagnosis was the side on which the abscess was situated, and this was cleared up by the ophthalmologic examinations, which disclosed more advanced optic neuritis on one side than on the other. The essential details in this case are as follows:

A boy aged six years was first seen at The Mayo Clinic June 23, 1927. Acute right frontal sinusitis had developed October 15, 1926, and on admission a sinus was draining over the right supra-orbital area. Operation was performed elsewhere October 17. The wound healed in eight weeks, but soon broke down and drained until January, 1927. It remained closed for a week, and was then opened; between January, 1927 and the date of my examination it was necessary to open the wound three times.

Examination of the nose and its accessory sinuses was negative and there was no evidence of a sequestrum in roentgenograms of the frontal bones. It was thought that the child was suffering from osteomyelitis of low virulence, and the treatment recommended was the exposure of the draining area to ultraviolet light, together with general tonic measures. This treatment was continued at the child's home for eight months when the sinus healed (February, 1928). In July, 1928 a swelling reappeared over the frontal sinus, and he began to have headaches. An incision was made and it healed promptly, with relief of all symptoms. He remained well until September 24, when there was sudden onset of attacks of headache, chiefly in the left frontal area, associated with projectile vomiting; each attack lasted for about twenty minutes. This state of affairs cleared up after three days and the child remained well for two weeks, when he had similar attacks of headache over a period of two days. Thereafter he was free from symptoms until four days before the second admission, when he was awakened during the night by intense headache; this was relieved by lumbar puncture.

Examination of the nervous system October 24, 1928 was essentially negative. The hemoglobin was 72 per cent, erythrocytes numbered 4,350,000 and leukocytes 10,900 for each cubic millimeter; the Wassermann reaction of the blood was negative. During the six days the child remained under observation before operation, his temperature ranged from 97.8° to 99.4° F., and the pulse varied from 82 to 110 each minute. Ophthalmologic examination disclosed bilateral choked disks, in the right eye of from 3 to 4 diopters, with some hemorrhagic areas, and in the left eye of from 2 to 3 diopters; vision in both eyes was 6/30. The leukocyte count rose to 16,300 October 27. The diagnosis was abscess of the frontal lobe. Although the headaches had been more severe on the left side, it was felt that the higher degree of optic neuritis on the right side indicated a right-sided abscess. Accordingly, October 29, I excised the site of the old sinus in the skin; the periosteum was found to be thickened and stripped off the frontal bone, but there was no pus beneath it; a burr-hole made into the right frontal sinus showed that at the previous operation it had been opened, and that the septum between it and the left frontal sinus had been broken down. After removal of some chronically inflamed mucous membrane from the walls of the sinus, the posterior bony wall looked perfectly normal. This was now removed and the dura was cautiously raised, but a stalk of connection to an abscess could not be found. Next an area of dura about 2.5 cm. in diameter was dehydrated by means of the Cushing-Bovey electrosurgical unit, so as to seal off the subarachnoid space from possible infection. A blunt cannula, passed into the frontal lobe through this area in an anteroposterior direction encountered resistance at a depth of 4.5 cm. (Fig. 361, *a*). It required a sharper needle to overcome this resistance, and when this had been done, 15 c.c. of thick grayish odorless pus was withdrawn by a syringe. A track was then formed between the abscess and the exterior by incising along the needle with a blade carrying a coagulating current; this diminished bleeding to a noteworthy degree and permitted the introduction of a speculum. The walls of the cavity, as then disclosed, appeared very firm; two drainage-tubes were introduced in position and were fixed by sutures to the skin. A small piece of iodoform gauze was loosely packed into the frontal sinus and the wound was partially closed. The bacteriologist reported that a staphylococcus had been cultured from the pus.

After operation there was little drainage from the tubes. Although the boy did not have fever, he complained of headaches, and on several occasions was incontinent of urine while asleep. I felt that possibly I had overlooked a pocket of the original abscess and decided to make another examination under an anesthetic. Accordingly, November 8, I reëxposed the original track. On careful palpation with the finger I could not find evidence of a diverticulum leading from the original cavity. In view of the fact that another abscess might be present, I passed a needle in different directions in the frontal lobe, and finally on the very lateral aspect of the lobe, and near the orbital plate, I encountered a second abscess from which I was able to withdraw 20 c.c. of pus (Fig. 361, *b*). As the second abscess was so far lateral, I felt that it would be impossible to drain it successfully by throwing the two cavities into one and draining both through the frontal sinus track.

An incision was therefore made over the temple, corresponding to the most superficial part of the second abscess, and the dura was sealed off with the electrocoagulating current as before. The abscess was entered 0.75 cm. from the surface of the cortex. A strip of the wall intervening between the two abscesses was removed until there was no ridge of brain tissue between their lowest levels, and one fenestrated tube was passed from the frontal opening in the skull to the temporal opening.

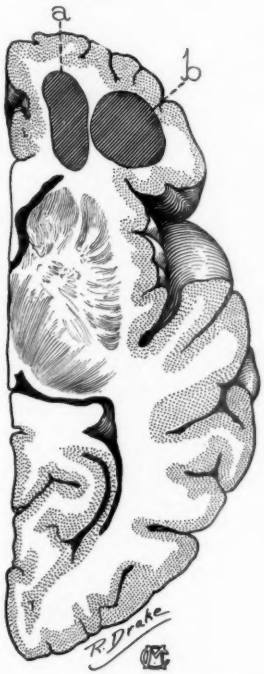


FIG. 361.—Transverse section of right cerebral hemisphere showing approximate position of the two abscesses: *a*, The first abscess which was drained; *b*, the second abscess which was drained.

The postoperative course was quite uneventful. The patient left the hospital, November 17, 1928, ten days after the second operation. The tube was removed, December 18, and the wounds were kept open for a week longer with small pieces of gauze soaked in 1 : 1,000 solution of acriflavine. November 23, the choked disk had subsided to a height of 1 diopter in each eye, and vision was 6/20 in both eyes without correction for myopia; January 3, 1929 there was only slight blurring of each disk margin remaining. The

patient was dismissed January 4, having gained 20 pounds during convalescence; on that date examination of the central nervous system was negative. The wounds were healed and there was no suspicion of cerebral hernia. Although previous to operation the parents had insisted that there had been no change in disposition, his behavior during convalescence was brighter and happier and quite different from his irritability before drainage of the abscesses was instituted.

## MENINGIOMA OF THE SPINAL CORD WITH EXTRADURAL SPREAD

Although it is not uncommon for a meningioma attached to the cranial dura mater to show signs of local malignancy by infiltration of the overlying structures, these tumors rarely exhibit this tendency if they are situated in the spinal canal. In Elsberg's series there were three such cases, and Dandy recorded a case in which the tumor is said to have originated in the body of a vertebra, whence it extended through the dura mater to occupy an extradural position. I have recently had under my care a case of tumor of the spinal cord in which extensive extradural spread was disclosed at operation; moreover, the histologic characters of the extradural and intradural portions of the growth were quite different. The essential details are as follows:

A woman aged fifty-three years came to the clinic October 19, 1928, complaining of paralysis, complete in the lower extremities and partial in the upper extremities. Three years previously she had suddenly begun to experience dull aching pain in both arms (although the more acute pain was felt in the left arm) and also beneath and between the shoulder blades. After persisting for three months, the pain disappeared spontaneously. Following a brief interval of freedom from symptoms, she began to feel weakness about the left knee-joint, and shortly afterward similar weakness appeared in the right knee-joint. At the same time the lower lumbar region became stiff, and in it was felt a dull aching distress, accentuated by bending the spine. A year previously there had been sudden increase in the degree of paralysis of the lower extremities and this became complete ten months before examination. Two and a half years before, she had noticed loss of power in the left hand, which progressed slowly, and seven months prior to admission weakness in the right hand appeared. A year previously she had noticed impairment of pain, temperature, tactile and joint senses, beginning in the lower extremities. This gradually became more profound, and finally involved the whole body as high as the nipple line.

Neurologic examination of the motor system revealed complete paralysis of all of the muscles of both lower extremities and of the abdomen. In the upper extremities the degree of paralysis differed on the two sides; thus, on

the left side there was complete paralysis of the interossei, opponens pollicis, flexor longus pollicis, hypothenar muscles, flexors of the fingers, extensors of the fingers, flexors of the wrist, and pronators of the wrist, while the extensors of the wrist and the triceps were partly paralyzed and there was but slight weakness in the latissimus dorsi and deltoid muscles. Weakness could not be detected in the brachioradialis, biceps, and brachialis anticus. On the right side, paralysis had not progressed so far, but the relative degree of palsy of the different muscle groups corresponded to that on the left side. The sensory findings were as follows: on the body, loss of all forms of sensation was complete as high as the level of the ninth thoracic segment, above which there was considerable impairment as high as the level of the second thoracic segment; in the upper extremities, the areas supplied by the seventh and eighth cervical segments and the first thoracic segment showed impairment of all forms of sensation. The tendon reflexes were markedly diminished in the upper extremities, with the exception of those subserved by the fifth and sixth cervical segments; the patellar and Achilles reflexes were obtained only with difficulty; all three abdominal reflexes were absent on both sides and both great toes showed a marked extensor response on stimulation of the soles of the feet. Tonic spasms of the lower extremities were frequent and painful and were excited by almost any stimulus applied within the anesthetic area. Both vesical and rectal sphincters were relaxed.

Combined lumbar and cisternal punctures revealed data as follows:

| | Lumbar. | Cisternal. |
|---|---|---|
| Total protein..... | 200 mg. for each 100 c.c. | 40 mg. for each 100 c.c. |
| Lymphocytes..... | 3 for each cubic millimeter | 1 for each cubic millimeter |
| Polymorphonuclear leukocytes..... | None | None |
| Erythrocytes..... | None | Many |
| Colloidal gold test... | 0012233321 | 0001221000 |
| Colloidal benzoin test | 000 003 333 333 200 | 000 003 333 100 000 |
| Color..... | Clear | Clear |
| Turbidity..... | Negative | Negative |
| Pressure..... | 4 to 0 cm. of cerebrospinal fluid | 15 cm. of cerebrospinal fluid |
| Jugular pressure..... | No response | Normal response |

Roentgenograms of the spinal column were negative. The preoperative diagnosis was tumor of the spinal cord, at the level of the seventh and eighth cervical segments and extramedullary in position. As the symptoms of motor paralysis had preceded the sensory loss, it was presumed that the tumor had begun anterior to the cord.

At the time of operation, October 25, 1928, I removed the spines and laminæ from the fifth, sixth, and seventh cervical vertebræ and from the first thoracic vertebra; the interspinous ligaments were much thickened in a nodular fashion, and were adherent to the dura. A specimen of tissue was removed from the extradural space, examined by the rapid method, and reported by the pathologist to be endothelioma. This extradural tumor

reached on the left side of the spinal dura from the level of the fourth cervical vertebra to the level of the first thoracic vertebra, and on the right side of the dura from the sixth to the seventh cervical vertebræ. As much as possible of the friable tissue was removed piecemeal, and the dura was then opened; the only intradural tumor found was a small nodule, about 0.5 cm. in diameter, attached to the dura anterior to the cord at the level of the fifth cervical vertebra. A small piece of this was removed for microscopic examination, but I thought it unwise to attempt to connect the intradural and extradural operative fields by removing the whole of the tumor. Such dissection, of necessity extradural, would have meant exposing the posterior surfaces of the bodies of at least two and possibly three vertebræ, and the hemorrhage from such a procedure would be formidable. Furthermore, at a later date, the reactive and reparative processes after so extensive an exposure of cancellous bony tissue would have given rise to a considerable mass of callus

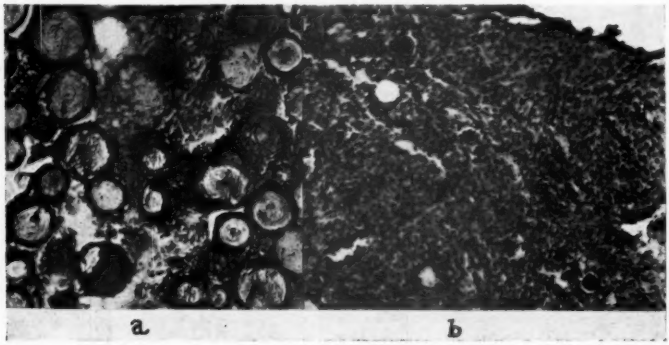


FIG. 362.—*a*, Intradural portion of tumor, a meningioma, almost entirely composed of fibrous whorls; *b*, extradural portion of a cellular tumor in which whorls are very infrequent (× 150).

and scar tissue. The operation was therefore completed as a decompression, the dura being left open.

Microscopic examination of tissue showed great differences in structure between the intradural and the extradural portions of the tumor; the former presented the picture of a typical slowly growing psammoma, with many whorls, and the latter was much more cellular and contained few whorls (Fig. 362). In fact, the extradural portion of the tumor had a similar histologic structure to that of the malignant endotheliomas of the cranial cavity recently described in detail by Craig.

The patient's convalescence was uneventful save for continuance of the painful involuntary spasms which had been present before operation. These were very refractory to drugs and to mechanical attempts at controlling them by means of extension and by means of a plaster bandage. There was early improvement in the neurologic symptoms; thus, November 1, 1928 the right

arm had regained full feeling while in the left arm there was only moderate lowering of sensation limited to the ulnar aspect. There was also some increase in power in the interossei and in the flexors of the wrist and fingers of the right hand. The patient was dismissed November 14, 1928, still wearing an indwelling catheter, as although the expulsive power of the bladder was improved, there was still about 100 c.c. of residual urine. At the end of a month it was reported to us that she could feel "touch" all over her body, but the painful muscular spasms continued.

In view of the limited operation which was performed, the rapid restoration of conduction in the cord is very gratifying. Moreover, it leads me to hope that it may be possible to remove the remainder of the tumor by a second operation, as the functional recovery of the cord has been so good as to justify the additional risk.

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# RADICAL CURE OF UMBILICAL HERNIA

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THE majority of acquired umbilical hernias occur in obese middle-aged women. Repeated pregnancies, lack of muscular tone, and relaxation of the abdominal walls following rapid emaciation or respiratory disorders, such as chronic bronchitis, which throw additional strain on the recti muscles are predisposing factors. W. J. Mayo has stated that the actual cause of the condition depends on an increased vertical and, to a lesser extent, a lateral lengthening of the abdominal walls followed by downward traction of the walls and their contents brought to bear on the relatively fixed and anatomically weak umbilicus. In this way separation of the recti muscles and protrusion of this purely fascial area are brought about. When seen by the surgeon these hernias have usually been present for many years and with their strong tendency to increase in size progressively may reach such enormous proportions that repair can be effected only with the greatest difficulty. At this stage the fascial coverings are thinned out and densely adherent to the subjacent peritoneum and to the contents of the sac. Owing to bands of fibrous tissue, the sac itself contains alcoves and channels and cannot easily be defined without danger of injury to the underlying bowel. Moreover, the recti muscles are widely separated and so atrophic that their satisfactory approximation and suture is not possible.

Prior to 1903 when W. J. Mayo published his first paper on the technic of a procedure for the radical cure of umbilical hernia results from any type of operation then in vogue were so bad that one could hardly speak of a radical cure, and whatever the treatment the percentage of recurrences varied directly with the size of the hernia. Added to the fact that strangulation in this

type of hernia is all too common and notoriously dangerous, one cannot be surprised at a recurrence rate of 75 per cent for large hernias and a mortality rate of 50 per cent for those in which strangulation had occurred.[6]

Small umbilical hernias do not, as a rule, cause symptoms. This is unfortunate, for when they are small repair is easy and recurrence rare. In case of larger hernias, however, the patient seeks relief of abdominal discomfort and pain due to the drag of the omentum or of the mesentery of the intestinal coils within the sac. Inflammation in the contents, producing adhesion of the components of the hernia, also gives rise to more severe attacks of pain and is the prologue of further serious trouble. Finally, when definite symptoms of acute or chronic obstruction arise, the prognosis is exceedingly grave.

As has been mentioned, the Mayo operation is based on the fact that the abdominal wall is too long and pendulous in a vertical direction and so is easier to overlap from above down than from side to side. It is generally admitted to be the most satisfactory procedure of all those proposed, and its growing popularity in the last twenty-five years leads one to the conclusion that it is in every sense a radical cure for practically any type of umbilical hernia. The following case illustrates its successful use in a most discouraging case, a huge strangulated umbilical hernia coincident with marked obesity and high blood pressure.

The patient, a woman aged sixty years, was admitted to the hospital complaining of severe pain in an old umbilical hernia. Twenty-eight years before admission she had first noticed a painless increase in the size of the umbilicus. Ten years after the onset it was about 6 cm. in diameter. At this time she experienced a constant dull dragging sensation in this region with occasional sharp attacks of severe pain. For many years she was able to reduce the hernia but finally it became irreducible and irregular in shape. Nine hours prior to admission there was an onset of acute abdominal pain accompanied by nausea and vomiting. The hernia, particularly, became tense and exquisitely tender.

The patient weighed 226 pounds. The transverse diameter of the hernia was 45 cm. and the vertical 30 cm. The abdomen was tender and rigid throughout. The systolic blood pressure was 240 mm. of mercury, the diastolic 122. There were small amounts of blood, albumin, and pus in the urine.

Chemical examination of the blood was negative except for slight elevation of the blood urea. A diagnosis of strangulated irreducible umbilical hernia was made and an emergency operation advised. Owing to the patient's age, obesity, and high blood pressure, the immediate prognosis was considered to be exceedingly grave.

Under local and gas anesthesia transverse elliptical incisions were made, including a large section of the fatty abdominal wall. The hernial ring was sectioned on each side and a finger introduced into the sac. This contained nearly all the omentum and one loop of ileum which already showed marked evidence of strangulation, but mesenteric thrombosis could not be detected and the wall of the bowel appeared viable. The omentum and sac were adherent in numerous areas, requiring resection of two-thirds of the omentum, and the careful separation of several coils of small intestine. The contents were then reduced into the abdomen and a vertical overlapping herniorrhaphy was performed after the method of W. J. Mayo.

## COMMENT

The length of time such a hernia has been present, the close union of the sac and its covering, their irregularly loculated and thinned-out nature and the matted adherent condition of the omental and intestinal contents unite to offer the surgeon a problem in the identification of the component parts of the lesion. The dangers and difficulties encountered in dissecting an umbilical hernia are emphasized by Cullen.

Much time can be saved in an otherwise tedious dissection if the suggestion of the late Joseph Ransohoff is followed, that is, of making a lateral incision directly into the abdominal cavity at the neck of the hernia. The index-finger may then be inserted into the sac and used as a guide for further dissection, for exploring the contents of the sac, and for returning any free intestinal coils to the peritoneal cavity. Adherent omentum may be ligated at the internal opening and intestinal loops adherent to the walls of the sac dissected free, leaving a section of the wall of the sac attached to the bowel. Perhaps the most important step in a successful operation is the wide exposure of the neck of the sac, leaving a large expanse of fat-free aponeurosis from which good flaps may be fashioned and a true fascia-to-fascia overlapping approximation obtained. In 1895 W. J. Mayo repaired umbilical hernias by just overlapping the fascia from side to side in three cases and from above down in two. The

latter method was quickly seen to be superior to the former both as regards ease in performance and permanance of cure. Of thirty-five cases subsequently reported by him partial failure occurred in one only. The original technic as he described it can scarcely be improved on:

1. Transverse elliptical incisions are made surrounding the umbilicus and hernia; these are deepened to the base of the hernial protrusion.

2. The surfaces of the aponeurotic structures are carefully cleared about 3.75 cm. in all directions from the neck of the sac.

3. The fibrous and peritoneal coverings of the hernia are divided in a circular manner at the neck, exposing its contents. If intestinal viscera are present, the adhesions are separated and restitution made. The contained omentum is ligated and removed with the entire sac of the hernia.

4. With forceps the margins of the ring are grasped and approximated; whichever way the overlapping is more easy of accomplishment suggests the direction of closure.

5. Beginning from 2.5 to 3.75 cm. above the margin of the upper flap, three to four silver-wire mattress sutures are introduced, the loop firmly grasping the upper margin of the lower flap; sufficient traction is made on these sutures to enable peritoneal approximation with a running suture of catgut. The mattress sutures are then drawn into position, sliding the entire lower flap into the pocket previously formed between the aponeurosis and the peritoneum above.

6. The free margin of the upper flap is fixed by catgut sutures to the surface of the aponeurosis below, and the superficial incision closed in the usual manner. The lateral approximation is carried out by sliding one side under the other in the same manner. In the larger hernias the incision through the fibrous coverings of the sac may be made somewhat above the base, thereby increasing the amount of tissue to be used in the overlapping process.

The use of silver-wire mattress sutures has been replaced by either mattress sutures of No. 1 chromic catgut or a continuous suture of the same material.

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# AVULSION OF THE SKIN OF THE PENIS AND SCROTUM

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ACCIDENTAL injuries of the penis and scrotum are rather infrequent, and when they occur are usually sufficiently severe to require the most careful consideration concerning the possibility of restoring the parts to normal, both anatomically and functionally. If any doubt exists in the patient's mind that the sexual function may be partially or completely impaired, great mental depression, or even chronic invalidism, will follow. Complete avulsion of the skin from the penile shaft or scrotum requires skin grafting, the nature of the injury largely determining the type of graft used. In the following case Thiersch grafts were found to give an excellent result.

A boy aged eighteen years was admitted to The Mayo Clinic with complete avulsion of the skin of the penis and the anterior two-thirds of the scrotum. While working in an ice cream factory he had fallen astride a rapidly revolving pulley and was carried around the shaft several times. His clothes were torn off and the skin of the penis and scrotum was avulsed. He was then hurled to the ground ten feet below. On admission the patient was in severe pain from a distended bladder, although he had voided once immediately following the accident. The skin of the entire shaft of the penis and about two-thirds of the scrotum was absent, leaving a raw bleeding surface. The urinary bladder was palpable at the level of the umbilicus and it was immediately emptied by gradual decompression. The urine and blood were essentially normal.

For two days tannic acid dressings were applied to the injury, followed by vaselin dressings for three days. On the sixth day sitz baths twice daily were begun and sterile dressings soaked in physiologic solution of sodium chlorid were applied every three hours. Infection subsided and the denuded area was covered with healthy granulations. Fifteen days after admission the patient had a chill and the temperature rose to 103° F. The patient complained of headache, a dull pain in both lumbar regions and some frequency and dysuria. Several specimens of urine showed 25 to 50 pus cells in each high-power field. A diagnosis of cystitis or possibly mild pyelonephritis was made. Ten grains of urotropin was given three times a day and 10 c.c. of a 1 per cent solution of mercurochrome in 500 c.c. of physiologic

solution of sodium chlorid was administered intravenously. The temperature gradually returned to normal in five days.

FIG. 363.—Lateral view of the penis and scrotum.

FIG. 364.—Ventral view of the penis and scrotum.

Twenty-eight days after admission to the hospital the avulsed areas were cleansed with physiologic solution of sodium chlorid with a stiff brush to remove the excessive granulations, and the resultant bleeding stopped by pressure with sponges soaked in hot physiologic solution of sodium chlorid. Several Thiersch grafts taken from the right thigh were then applied to the denuded areas and retained in place by the firm pressure of vaselin gauze strips. The penis was held perpendicular to the abdomen during the period by large gauze pads and the dressings reapplied every three days. The grafts took nicely and the patient was dismissed twenty-six days after the operation with a freely movable penile and scrotal covering. The result, as can be seen from Figures 363 and 364, appeared entirely satisfactory.

We have found two reports of similar cases in the literature. In one case (Benedict's) short circuiting of a high-frequency current through the penis destroyed the skin only. The injury was repaired by full-thickness grafts obtained from the scrotum. Benedict pointed out the necessity of proper preparation of the field for the graft and stated that the base of the flap should be considerably wider than the part elevated in order to maintain the nutrition of the graft. In the second case (Cottle's) the patient was repairing the gear on a revolving shaft when his trousers became caught by a projecting pin, resulting in the complete avulsion of the skin of the penis and scrotum along with the left testicle. After careful preparation the right testicle was implanted beneath the skin of the right thigh and the penis was inserted through a full-thickness skin flap raised from the skin of the left inguinal region after external urethrotomy. The testicle was allowed to remain in its new bed permanently. The penis was removed from its bed by a two-stage operation, the first of which consisted in severing the skin below and suturing it around the penis, leaving the broad upper margin of skin attached for several days in order to maintain nutrition, and the second operation consisted in simply severing the upper margin of skin and uniting it behind the penis to the other edge of the graft. The result was satisfactory. It would seem that in cases in which the application of multiple Thiersch grafts will leave a freely movable integument on the penile shaft they should be utilized. If, however, denudation has been so extensive that every vestige of loose connective tissue has been stripped from the corpora cavernosa and corpus spongiosum it

is best to consider a full-thickness graft either from the thighs or from the anterior abdominal wall. In all cases it is necessary to prepare carefully the area to be grafted and to reduce infection to a minimum. As this may take several days, ample time is given to decide on the method likely to give the best result.

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# CONGENITAL TRACHEO-ESOPHAGEAL FISTULA: REPORT OF A CASE

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HOLDERMAN published a complete review of the literature on this subject in 1927 and added a case of his own, making the total number 218. Since then Stamm and Kipper have each added a case. The case reported here brings the number to 221. The rarity of this anomaly is probably more apparent than real, although Shukowsky and Baron found only one case in 50,000 hospital cases. Incorrect diagnoses and failure to secure necropsy probably are the two factors which account for the small number of cases reported.

## EMBRYOLOGY

According to Lewis and Stöhr, "In a 2.5 mm. embryo the foregut extends upward from the yolk-sac from which is formed the stomach, esophagus, and pharynx. Very soon the respiratory apparatus, consisting of the larynx, trachea, bronchi, and lungs, arise as a median ventral outgrowth of the foregut, immediately behind the last pharyngeal pouches. When the lung-bud begins to develop the foregut is laterally flattened, so that its lumen is a dorsoventral cleft. The lung-bud develops as a pear-shaped swelling, directed downward, on the ventral border of the foregut; and this swelling becomes split off, from below upward, to form the trachea, which is first short but rapidly elongates. The upper end of the trachea with the cartilages which develop around it constitute the larynx. At the lower end of the trachea the pyriform dilatation spreads out on either side to form the primary bronchi. The cavity of the trachea is still in free communication with that of the esophagus. It will become separated from the esophagus by the down growth of the lung-bud and the upward extension of the notch between the lung-bud and the esophagus."

Keibel and Mall stated: "In the most common anomaly of the esophagus, which must arise at the stage under consideration, the esophagus is transversely divided into two parts. The upper portion ends blindly below, and the lower portion arises from the trachea near its bifurcation, or even from a bronchus, into which its lumen opens. Sometimes the two portions of the esophagus are connected by a strand containing smooth muscle-fibers, 'but it is entirely unknown whether there is any remnant of epithelium in the interval.' No epithelial connection has been recorded. Although this complex anomaly is common, a simple communication between esophagus and trachea, when these are otherwise normal, is extremely rare. To produce the common form of the anomaly the lower portion of the tracheo-esophageal septum must fail to develop, thus leaving the esophagus in communication with the lower part of the trachea."

## REPORT OF A CASE

A baby girl aged five days was brought to the hospital March 15, 1928, emaciated and dehydrated. She was one of a pair of twins of a seven months' pregnancy. The delivery was normal. As soon as the child was given breast

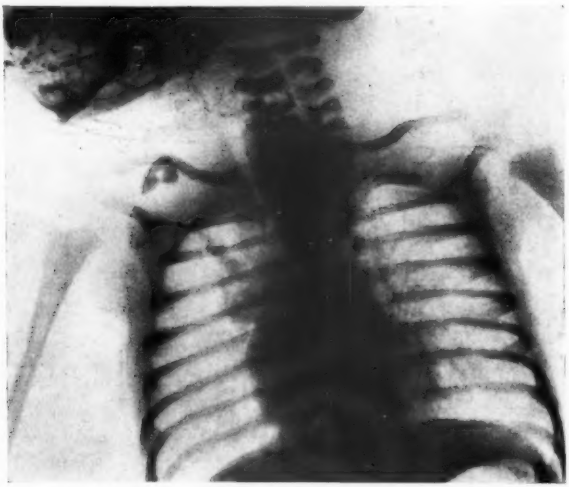

FIG. 365.—Stricture of esophagus opposite the third rib.

milk she appeared to have difficulty in deglutition. She would take about 5 drams and almost immediately vomit the entire amount. A No. 8 French catheter which was passed through the pharynx into the esophagus met with definite obstruction opposite the third rib. It was impossible to pass even the smallest filiform catheter through the esophagus. A roentgenogram of the esophagus after the infant had been given some barium cream revealed defi-

FIG. 366.—Stricture of esophagus at *a*, 3.5 cm. below the cricoid cartilage.

nite stenosis just opposite the bifurcation of the trachea (Fig. 365). There was no evidence of any other congenital defects. A tracheo-esophageal fistula was not suspected; thus gastrostomy seemed indicated.

March 16 the abdomen was opened through an upper left rectus incision under local anesthesia. The stomach was delivered into the wound and gastrostomy was performed after the method of Witzel. The peritoneum was sutured to the stomach around the tube and the wound closed with

interrupted No. 00 chromic catgut and dermal sutures. At the completion of the operation the infant was in good condition.

During the first twenty-four hours 1 dram of 5 per cent glucose was given through the tube every two hours. On the second day 0.5 dram of breast milk was added every two hours and increased to 2 drams on the third day. The child gained weight and had two to three yellow stools daily during

FIG. 367.—Continuation of esophagus with trachea from below at *a*, 4.5 cm. below the cricoid cartilage.

the first four days. She would occasionally cough up milk which had been introduced through the gastrostomy tube. This fact led us to believe that we were dealing with a tracheo-esophageal fistula. On the fifth day the baby aspirated a large quantity of milk which had been given through the tube and died the following day of aspiration pneumonia.

The pathologist reported congenital tracheo-esophageal fistula; congenital stenosis of the esophagus 4.5 cm. below the cricoid cartilage; recent gastros-

tomy; bilateral aspiration bronchopneumonia; cachectic atrophy of the thymus, and intense acute passive congestion of all organs.

A probe passed through the esophagus stopped 3.5 cm. below the cricoid cartilage where the lumen was completely obliterated (Fig. 366); a probe passed through the gastrostomy opening entered the trachea at a point on a level with the point of congenital stricture of the esophagus. On section of the esophagus from below at a point 4.5 cm. below the cricoid cartilage there was a direct communication between the esophagus and the trachea (Fig. 367). The mucous membrane of the esophagus was directly continuous with that of the trachea. At the point at which the esophagus became continuous with the trachea there was on the left side of the esophagus a small diverticulum, the orifice of which measured 6 by 2 mm. This diverticulum was separated from the esophageal pouch above by a thin layer of muscle and mucous membrane.

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